Railway Mechanical Engineer

Vol. 100 July, 1926 No. 7

From the standpoint of one accustomed to the riding characteristics of modern passenger cars, the motor bus appears to possess a severe handicap, partly because of the uncertain conditions of the line and surface of the roadways on which it must operate and partly because of the characteristics of a vehicle which must be made to operate successfully on such rough roadways. It is, perhaps, owing to these very handicaps that so much attention has been given by the designers of automobile and motor bus bodies to the development of seats which, both in the comfort—even luxury—of their form and upholstery tend in a measure to relieve the road shocks which cannot be kept out of the body of the vehicle and which in some cases may be intended to distract the attention of the patron from the inherent disadvantages of the road vehicle. Whatever may be the reason it is evident that in the motor bus considerably more has been done in recent years in the development of seat comfort than has been evident in the case of railroad passenger coaches. The influence of this new development, however, partly because of its growing competition and co-ordination with railroad service, is beginning to be felt by the designers of passenger coaches and coach equipment. It is well worth the study of railroad officers interested in the equipment of passenger coaches because, while what has been done with the road vehicles, is not directly applicable to the passenger car, it is suggestive of what can be done, in modified form, in the passenger car. The argument that present equipment is sufficiently luxurious and ought to satisfy the traveler is not sufficient to justify inattention to this new development.

Influence of the motor bus

One of the marked trends of the times in the field of car repairs is the application of the principles of repetitive operations and the specialization which characterizes so many American producing industries. On another page in this issue will be found an interesting account of the application of these principles in the Little Rock car shops of the Missouri Pacific where the operations have been organized on the station to station basis. The operations described in this article pertain to the rebuilding of a series of flat cars, and it is significant that the specialization of operations by stations, with the concentration of the deliveries of each class of material at individual stations, is reported to have effected a reduction of 38 per cent in the rebuilding cost. Probably one of the greatest difficulties in the way of securing to the full the advantages of this type of specialization in car repairs is to take out of service cars of a single series in sufficient number to maintain the continuous program of rebuilding required to permit a highly specialized organization of facilities especially adapted to the one series of cars. In the article already referred to, it is probable that less difficulty in this respect was encountered than would be the case were a series of box cars under consideration, because of the generally greater extent to which the latter are scattered in interchange. In this connection, it is worth while calling attention to the fact that with the adoption of standard box car designs, if these designs are generally utilized by the railroads, the differences in cars of various series on any individual road will gradually become of such minor character that they need not interfere with a highly specialized shop program involving cars of two or perhaps more series. It seems probable, then, that the program of standardization now being advanced with such satisfactory progress by the American Railway Association will greatly simplify the future application of specialization in freight car rebuilding by the railroad, and that it will probably greatly increase the extent to which specialization may be made to reduce rebuilding costs.

A future benefit of standard cars

Quite often the mechanical department officers of a railroad as well as the locomotive builders have been placed in an awkward position by the insistence of the executive on having new locomotives about to be purchased equipped with 100 per cent boilers. It is a common saying that a locomotive is as good as its boiler, but up to the present time no one has been able to define a 100 per cent boiler. Of course, the efficiency of a boiler can be calculated, and is calculated when designing new power. However, boiler efficiency is effected not only by the design of the boiler but by the grade of coal used and by the rate of operation as well. A maximum combined efficiency for a locomotive boiler has never reached 100 per cent although the application of superheaters and feedwater heaters have increased the efficiency to a figure closely approaching 90 per cent. What is really desired by the railroad is a locomotive that can furnish maximum sustained horsepower or tractive force at speeds and such performance can only be obtained by providing a boiler of adequate steaming capacity.

Purchasing locomotives for economy

Evidence that this important factor in locomotive design is receiving due consideration from both the mechanical department of the purchasing railroad and also the builders, is shown in some of the new motive power that has been purchased during the past few years. The feature in many locomotives of recent design has been the procurement of the required maximum sustained horsepower by the use of a boiler having ample

proportions, a firebox having ample grate area, heating surface and volume, and the application of the latest design in feedwater heaters, superheaters and stokers. In the final analysis it is the performance and economy of operation with which the executive is most concerned, and these are facts which can only be determined by trial in actual operation. The policy of determining these facts in advance has recently been followed by two railroads, one in the east and the other in the west, both of which purchased one locomotive for test before ordering more of the same design.

Diesel locomotive development

Elsewhere in this issue will be found a description of the second Diesel locomotive built by the Hohenzollern Locomotive Works at Dusseldorf, Germany, for the Russian State Railways. This locomotive is essentially a combination of a marine type Diesel engine, not primarily designed for locomotive use, with a quite conventional type of steam locomotive running gear. This locomotive is like its predecessor in respect to the power plant, but where the first locomotive utilized electric transmission, the present locomotive utilizes a mechanical transmission with magnetically operated clutches. Not many years ago in the early discussions of the possibility of using the Diesel engine as a locomotive prime mover the development of a satisfactory transmission was considered to be one of the most important, if not the most difficult, problems to be solved in connection with this development. The electric transmission, already well developed in its essential features, has now proved its entire practicability as an operating medium. In connection with the comparatively slow speeds of the best developed Diesel engines of the present time, however, it is open to the objection of its rather high weight which, in considering locomotives of sufficient size to meet general road service requirements in America, is a matter for serious concern.

With the mechanical transmission installed in the new Russian locomotive, combined with a type of Diesel engine not ideally adapted to locomotive service, it has been possible to develop a 1,200-hp. locomotive with a total weight of about 230 lb. per hp. of the prime mover, with an overall thermal efficiency on test of about 30 per cent. The new form of transmission, if a sufficient period of service demonstrates its practicability from an operating and maintenance standpoint, has the advantage of high efficiency, light weight and probably lower first cost, but it obviously does not possess the same degree of flexibility in the application and utilization of the power of the rail as does the electric transmission. This would suggest the possibility that with the comparatively low speed Diesel engines at present available, the mechanical transmission will be best adapted to road service where speed variations of the locomotive are largely confined within the range of the practicable speed variations of the Diesel engine, while the electric transmission will be far better adapted to services requiring frequent stops and starts and wide speed variations beyond the practicable range of engine speed variations, such, for instance, as switching service.

But there is the future possibility of the development of a Diesel engine operating at a crank shaft speed more nearly approaching that of the automobile engine than is customary at the present time. This will materially reduce the disadvantages of weight and first cost of the electric type of transmission, although a practicable mechanical type of transmission will still probably retain the advantage of higher efficiency.

That it has been possible to build a 1,200-hp. locomotive using an engine designed for an entirely different purpose and still keep within a weight of 230 lb. per horsepower is a very encouraging indication that neither present limitations of power capacity nor unit weight need be considered as anything but temporary. The submarine Diesel is a highly effective and reliable machine in its field. In Germany, particularly, its development, due to necessity, was rapid during the war. It would be extremely hazardous to attempt to prophesy the advances which a like amount of effort in the adaptation of this highly efficient form of prime mover to the specialized requirements of rail limitations may bring forth in the next few years.

Give the shop efficient material handling equipment

Prompt, accurate and economical delivery of material is one of the principal factors in car and locomotive shop production. That the importance of this factor is well understood and appreciated by the majority of mechanical and stores department officers is shown by the large number of shops in which well organized delivery systems have been installed. Still the best planned and most efficient system of delivery will not function 100 per cent unless the right kind of equipment is provided. As an example of the amount of material that is handled in many railroad shops, the case of a central car and locomotive repair point, located in the middle-west, can be cited at which over 9,500 carloads of company material is received in a year, approximately 30 per cent of which is used in the car and locomotive shops at that point. This means that a little over nine carloads of material is delivered to these two shops, each working day of the year. Because of the fact that a car and locomotive shop must, owing to the character of the work performed, spread over considerable territory, much time can be lost in handling this material over comparatively long distances unless the right kind of equipment and road facilities are provided.

Delivering material from the stores department to the car or locomotive shop is, however, only a part of the material handling problem. Appearing elsewhere in this issue is an article on handling material in railroad shops in which are given a number of illustrations showing applications of material handling equipment to various jobs occurring in shop operation. They are many jobs, such as moving heavy castings from one machine to another, or from the erecting shop to the machine shop and vice versa, for which special trucks or cranes can be used to advantage. For such work, many manufacturers are able to provide special equipment which is designed with the principal object of obtaining speed and reducing labor costs.

The work performed in the average railroad car or locomotive shop usually covers a considerable area and is done most efficiently on the same level. It is not generally practicable to centralize the work in a building of two or more stories where the material can be handled by conveyor or elevator. Furthermore, production is governed by the classes of cars and locomotives going through the shop, which is in turn governed by the railroad's traffic requirements. This makes the problems of production and handling material unlike those to be solved in the average manufacturing plant, and the highly specialized equipment found to render good service in manufacturing work will not always prove suitable in car or locomotive repair work. Material handling equipment, to be best adapted to railroad requirements, must

be able to make long hauls with heavy loads, out of doors under adverse weather conditions. Furthermore, no matter how well a car repair yard may be provided with hard-surface driveways, there will be times when a truck may have to work on the natural soil or in the mud.

The types of motorized equipment which are becoming available in constantly increasing variety are offering many opportunities for overcoming handicaps set up by the inflexibility of existing plant layouts or the lack of specialized facilities built into the plants themselves.

To err is human

The mechanical department officer is constantly confronted with the problem of maintaining accuracy in the work of his department. His work involving many or all of the various elements of mechanical engineering requires close attention to details as well as the bigger problems of organization and management. Engineering is an exact science and even though speed in production must be attained, that primary factor of accuracy must also be maintained. This point was discussed at considerable length in an address made by C. E. Johnson, vice-president and general manager, Kansas City Southern, before the Maintenance of Way Club, Chicago, on May 19. Mr. Johnson in dwelling on the shortcomings of human nature stated: "The man who says he never makes a mistake is either a liar or a loafer. Human nature is fundamentally imperfect and because of this fact, mistakes are made wherever human nature is employed. In every business, be it that of manufacturing calico dresses, selling ice cream cones, running a peanut stand or keeping books, errors of various kinds are constantly being made. Nor does recognition of the fact that 'to err is human,' obviate the necessity for enduring the commitments of error.

"Mistakes are expensive. They waste time, not only that involved in their perpetration, but also that necessary for their correction, both of which expenditures would be saved if the mistakes had not been made. Errors cost customers, money, time, goods, material, men or jobs, depending on the nature of the business and the tolerance of the one on whom the brunt of the error falls. In any event the sequence of errors is inescapable. Almost no price is too high to pay for increased accuracy."

The tendency in modern locomotive and car shop production is for accelerated speed. Speed is profitable if coupled with accuracy, but it is a nihilist if married to inaccuracy. This fact should mean much to mechanical department officers, since it should cause them to consider the elimination of errors before endeavoring to speed up production. Too often production takes precedence over efficiency and safety, both of which are products of accuracy.

Terminal practices and repair costs

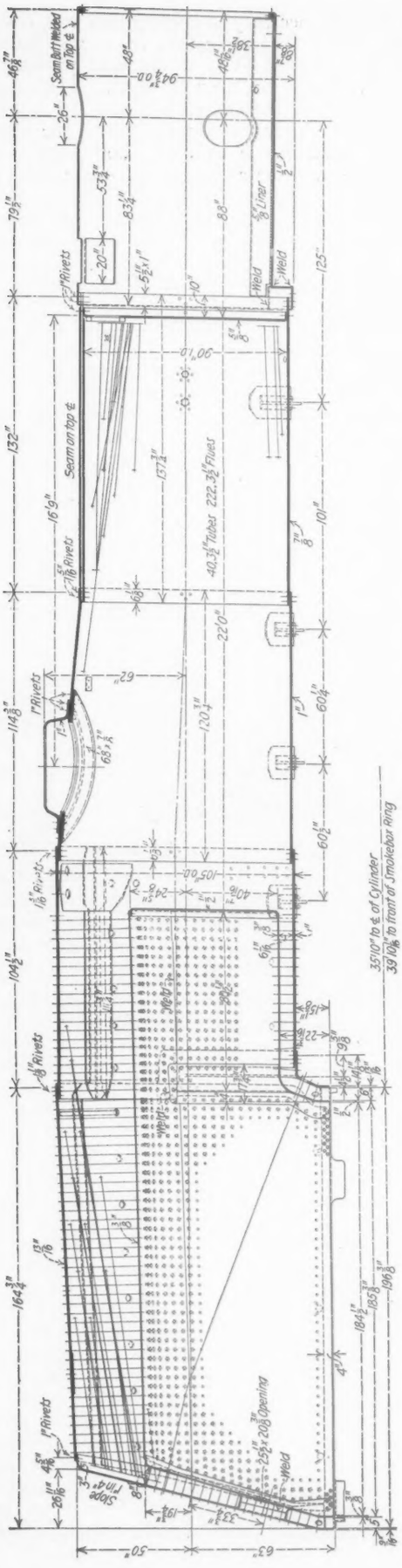
There can be no question that even with locomotives of the same class and service making the same mileage between general repairs, the cost of these repairs will vary, depending upon the kind of conditioning work performed at engine terminals. Among the things which can be done in enginehouses to reduce the cost of classified repairs may be mentioned the following: (1) Keep the pound out of driving boxes and rods; these are responsible for much expense in the back shop due to fractures in frames, axles, crank pins and driving and piston rods. Many side rods crack through the knuckle pin oil hole, making it necessary to apply a new rod, costing perhaps $50, when the application of a new knuckle pin bushing at a cost of $1.45 would have prevented a fracture. (2) Keep the binders tight. The proper attention to assure tight binders will also do much to prevent cracked and broken frames, one of the expensive items of maintenance in back shop work. (3) Wash the boilers as often as necessary, with great care. The degree of thoroughness with which this operation is performed has a vital influence on the formation of scale, necessitating firebox and boiler sheet renewals. (4) Avoid repeated hammering of leaky staybolts which starts fractures in the sheets, also resulting in the necessity of applying new side sheets at the back shop when this work would have been unnecessary had new staybolts been applied when needed. (5) Don't work the flues too much. If expanders are used, any expansion of the flues beyond that necessary to make them tight in the flue sheets, results in excessive sheet expansion and the development of cracks. (6) Resist the temptation to rob material from locomotives prior to their being sent to the back shop for heavy repairs, with the idea of getting new parts in place of old or otherwise undesirable parts and charging the expense to the back shop. The back shop should assist the enginehouse by turning out locomotives after general repairs in as nearly as possible 100 per cent condition for operation. The enginehouse should reciprocate by following practices in locomotive conditioning and running repair work which will keep the locomotives in the best condition for efficient operation on the road and at the same time prevent the development of slight defects into serious ones, necessitating subsequent extensive and expensive repair operations in the back shop.

New Books

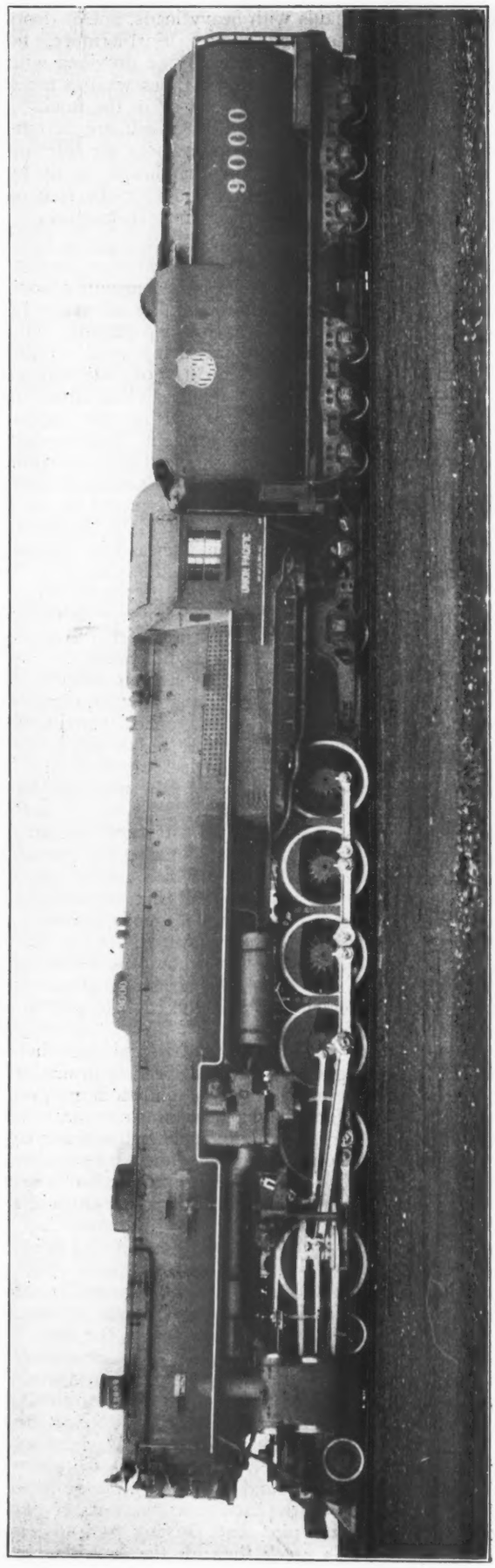
UP-TO-DATE AIR BRAKE CATECHISM. *By Robert H. Blackall. Revised and rearranged by F. H. Parke, general engineer, Westinghouse Air Brake Company, Wilmerding, Pa. Published by The Norman W. Henley Publishing Company, 2 West 45th St., New York. Bound in cloth, 7½ in. by 5 in., 710 pages, illustrated. Price* $4.00.

The Air Brake Catechism by Robert H. Blackall, has for many years been popular with railroad men whose work require a knowledge of the construction, operation or maintenance of air brakes. This, the thirtieth edition, has been revised by F. H. Parke of the Westinghouse Air Brake Company, who is a well-known authority on air brakes. Mr. Parke, following the method of question and answer used by Mr. Blackall in his earlier editions, has thoroughly covered the detailed construction and operation of the various types of Westinghouse air brakes used not only on railroad cars and locomotives, but on self-propelled rail cars and automotive equipment as well.

The book contains 250 questions and answers which cover in detail the ET locomotive brake, the K type quick service freight triple valve, the empty and load freight brake, the old PM high-speed brake, the LN passenger equipment, the present day PC and UC passenger brake equipments and the various steam and motor-driven air compressors. The book also covers the Westinghouse equipment for electric locomotives, high-speed electric passenger trains, motor trucks, buses and automobiles and gasoline motor-rail cars. There are also chapters on the standard terminal and compressor tests, hose specifications, train handling and inspection, foundation brake gear diagrams, tables, formulas and other useful information.



Sectional elevation of the boiler of the Union Pacific type locomotive



Three-cylinder Union Pacific type locomotive No. 9000, built by the American Locomotive Company

4-12-2 locomotive for Union Pacific

Built for fast freight service in mountain districts— Has 67-in. drivers and develops a rated tractive force of 96,650 lb.

ON April 9, 1926, the American Locomotive Company delivered a 4-12-2 type locomotive to the Union Pacific to be used in fast freight service in the mountain districts of that road. This locomotive, known as the Union Pacific type, is the largest non-articulated steam motive power unit ever constructed. The driving wheels are 67 in. in diameter which is somewhat larger than the usual diameter of drivers on locomotives designed for fast freight service, a 63-in. driver being generally accepted as about the proper diameter for such service. It was found, however, that a good crank axle design required a 67-in. driver which tended to improve the whole design of the locomotive for the work for which it was intended.

The design of the locomotive as a whole embodies straight engineering throughout, combining a number of accepted features in a manner that has not been used before in order to obtain the characteristics desired within the specified weights and clearance limitations. The locomotive develops a rated tractive force of 96,650 lb. The boiler steam pressure is 220 lb. per sq. in. The diameter and stroke of the outside cylinders is 27 in. by 32 in. and the inside, 27 in. by 31 in., the main rods for the two outside cylinders being connected to the No. 3 drivers and the main rod from the inside cylinder to the No. 2 drivers.

The total weight of the locomotive is 495,000 lb., of which 355,000 lb. is carried on the drivers, 80,000 lb. on the engine truck and 60,000 lb. on the trailing truck. The total length of the driving wheel base is 30 ft. 8 in., but by installing lateral motion devices on the No. 1 and No. 6 drivers, the designers were able to reduce the total rigid wheel base to 17 ft. 6 in.

Design is result of extensive tests of other types

The selection of the 4-12-2 design was the result of a series of extensive studies and tests made by the railroad management extending over a period of several years. These tests included an investigation of the operating costs of the 2-8-8-0 Mallet type, two-cylinder 2-10-2 type, and three-cylinder 4-10-2 type locomotives, a comparison of the principal dimensions, weights and proportions of which is given in one of the tables.

The 2-8-8-0 type locomotives were designed for service on the principal mountain grades of the Union Pacific, but during certain seasons, they were placed in road service between Green River, Wyo., and Laramie, where the maximum grade is .82 per cent. Considerable reductions were obtained in operating costs through the use of the Mallet locomotives but owing to the fact that locomotives of this type are inherently a low speed machine, they could not be used in this district during the busiest season.

Since 1917 the standard locomotive for fast freight service in the mountain districts has been the two-cylinder 2-10-2 type which has a rated tractive force of 70,450 lb. About one year ago the Union Pacific purchased a three-cylinder 4-10-2 type locomotive (a description of which was published in the September, 1925, issue of the *Railway Mechanical Engineer*, page 557), for demonstration and comparison with 2-10-2 type.* This locomotive was built as nearly identical to the 2-10-2 type as the three-cylinder design would permit, having nearly the same weight on the drivers, the same grate area and practically the same design of boiler, and 63-in. drivers.

The comparative tests conducted with the three-cylinder 4-10-2 and the two-cylinder 2-10-2, developed that the three-cylinder locomotive could regularly handle 20 per cent more tons in regular service with an expenditure of 16 per cent less fuel per 1,000 gross ton-miles. As a result, the Union Pacific conceived the idea and co-operated with the builders to design a locomotive for fast

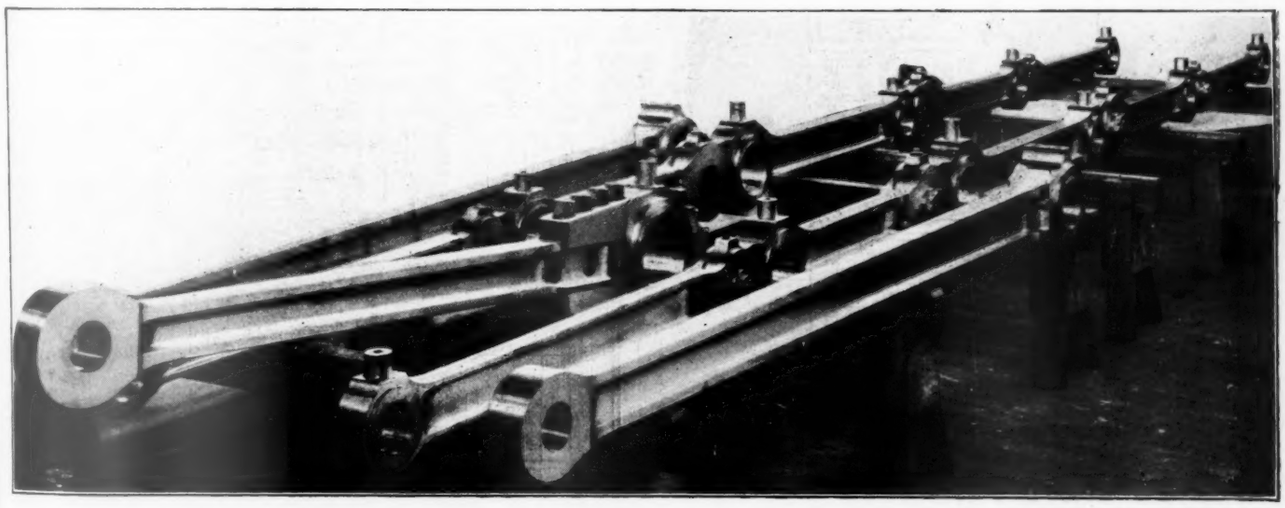
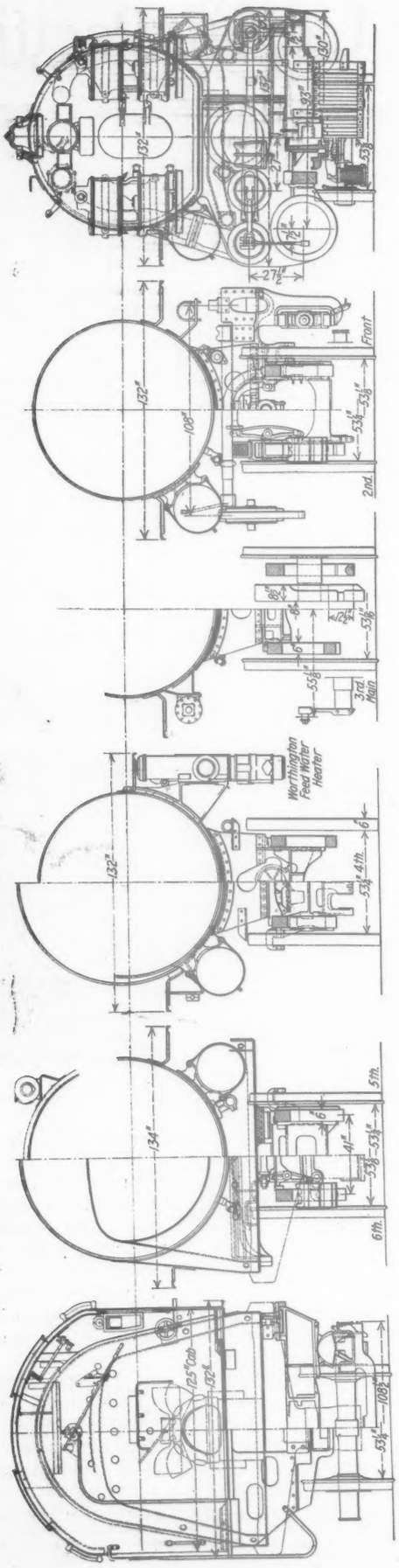
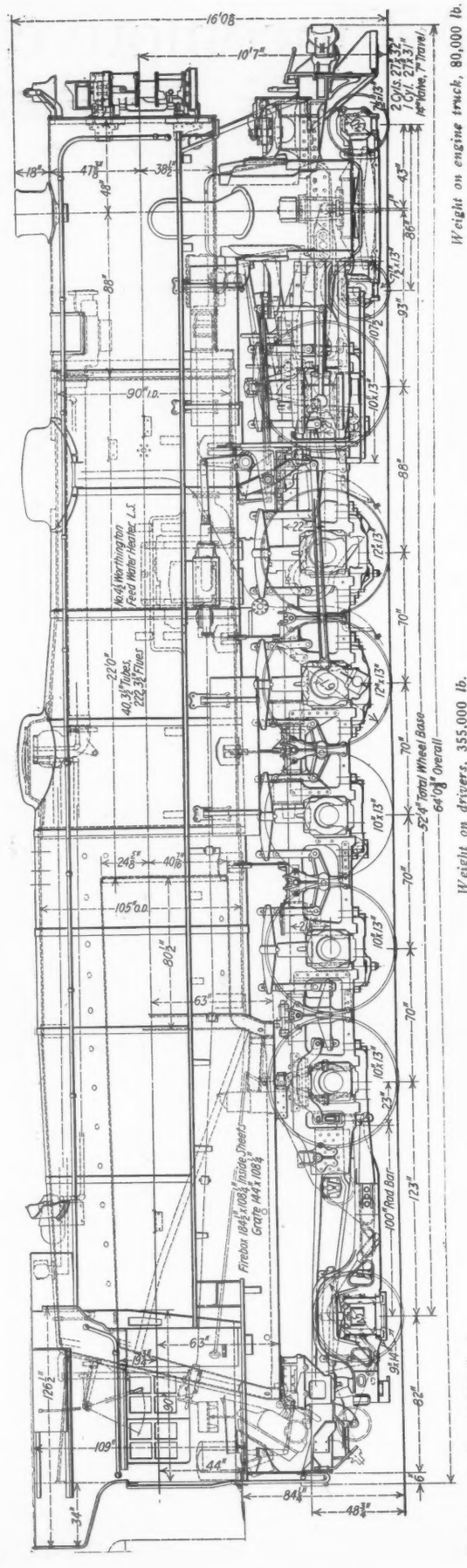


Illustration showing the arrangement of the side and main rods

* See the June, 1918, *Railway Mechanical Engineer*, page 321, for the results of the tests of the 2-10-2 locomotive on the Union Pacific.

Three-cylinder Union Pacific type locomotive No. 9000, built by the American

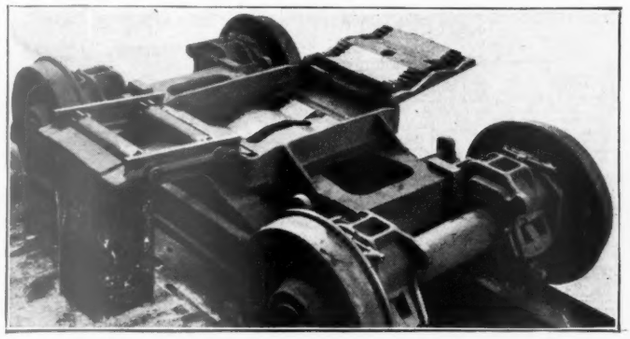




Elevation and cross section drawings of the Union Pacific Type Locomotive No. 9000

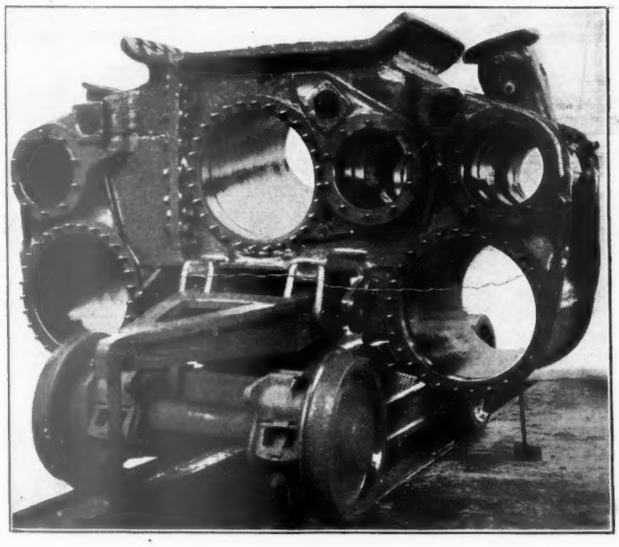
freight service capable of hauling the 2-8-8-0 tonnage and also of making the same speeds as made by the 2-10-2 and 4-10-2 type locomotives. In other words, it was desired to have an increase in permissible speed of from 20 m.p.h. to 40 m.p.h. and an increase in the average speed over the district of from 12 m.p.h. to better than 20 m.p.h.

The amount of power required together with a weight limit of 59,000 lb., per pair of drivers, determined the



Top view of the engine showing the construction of the centering device .

need for having six-coupled axles. Such a design was impossible on a two-cylinder locomotive having the main rods connected to a single driving axle. The three-cylinder locomotive, transmitting its power through two main driving axles, effects a better distribution of stresses over the whole frame structure. This factor, combined with the lower dynamic effects, made possible the use of six-coupled axles together with comparatively high speed



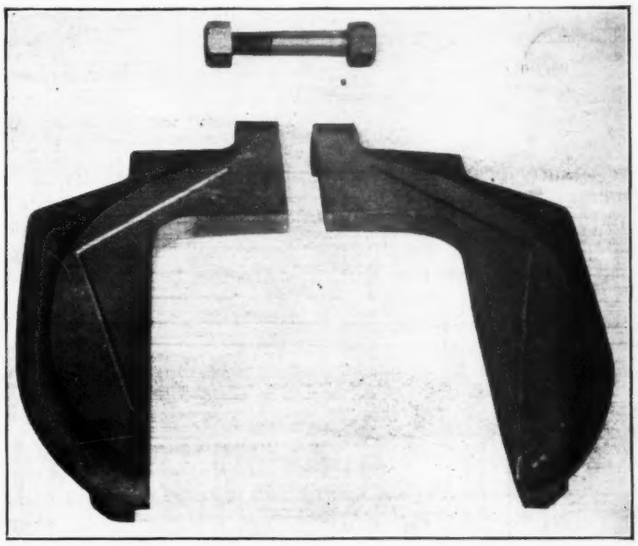
Rear view of the cast steel cylinders as assembled on the engine truck

and greater power. The final frame stresses are, therefore, somewhat less in the 4-12-2 type than they are on a 2-10-2 type having outside cylinders of larger dimensions.

The problem of arranging such a long wheel base as the 4-12-2 type to negotiate a 16 degree curve was solved by installing a lateral motion device at the rear as well as at the front drivers and applying a four-wheel engine truck and two-wheel trailer, the design of which allows a considerable amount of flexibility in curving. All the wheels are flanged with the exception of the No. 4 drivers which have blind tires. This arrangement permits the locomotive to traverse 16-deg. curves successfully at normal speeds. It has, however, been decided to have all the drivers flanged on future locomotives of this type.

Equipped with cast steel cylinders

One of the illustrations shows an assembly of the engine truck, front equalizer and cylinders. The cylinders are of cast steel, this being the first application of cylinders constructed of this material to a three-cylinder locomotive. The outside cylinders are placed horizontally in the usual manner while the center cylinder is built sloping at an angle of 9½ deg. to the horizontal. The steam pipe inlet, shown on the right hand side, supplies steam to both the right and center cylinders. It is designed to deflect any water which might be present in the incoming steam away from the center cylinder and into the right hand cylinder, from which the water can be more



Type of hub liners used on the engine truck boxes

easily drained. The cylinder casting is in two sections and is joined at the left of the center cylinder, as shown in the illustration. The exhaust passages from all three cylinders are cored to unite at the top of the casting in the usual manner. Gun iron bushings and rings are used in the cylinders and on the pistons and distributing valves.

The valves are of the piston type, size 14 in., and have a maximum travel of seven inches. A single ported valve is used having eight rings, which is the Union Pacific standard, instead of the usual four rings. The valves are operated by a Walschaert gear with the Gresley transverse lever arrangement for three-cylinder locomotives. This valve gear design illustrates the first use of an integral steel casting combining both link supports with a frame crosstie.

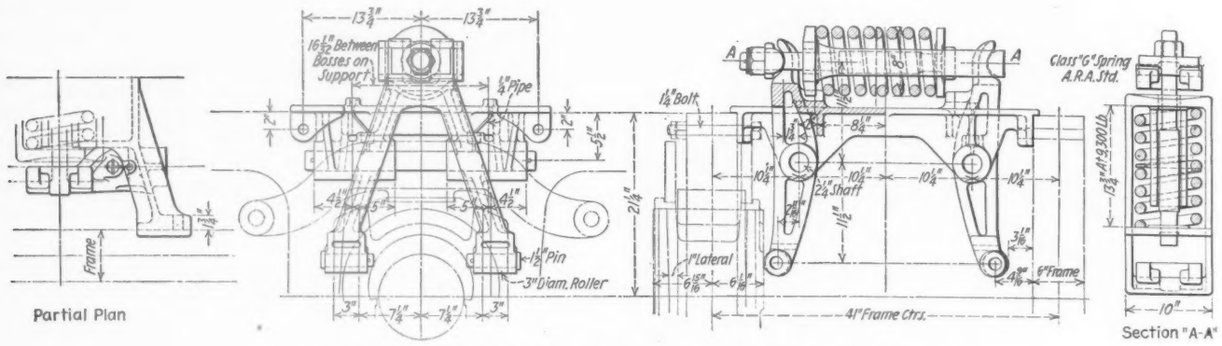
The steam pipe is enclosed in a Flextite casing which is a patented arrangement whereby the casing is welded to the outside of the smokebox and around the steam pipes. There is said to be a net saving in weight of approximately 80 lb. per locomtive and castings are eliminated, with attendant machine work and chipping. Properly welded, the casing will remain airtight indefinitely.

Design of running gear includes unique features

The design of the running gear involved a number of new problems owing to the fact that the locomotive would be required to traverse 16 deg. curves on six pairs of

driving wheels. This required an unusual amount of flexibility in the long driving wheel base but, as stated in a preceding paragraph, the designers were able to obtain a rigid wheel base of 17 ft. 6 in. by the use of lateral motion driving boxes applied to the front and rear axles.

The lateral motion device shown in one of the drawings is adjustable to suit speed or curvature requirements, the

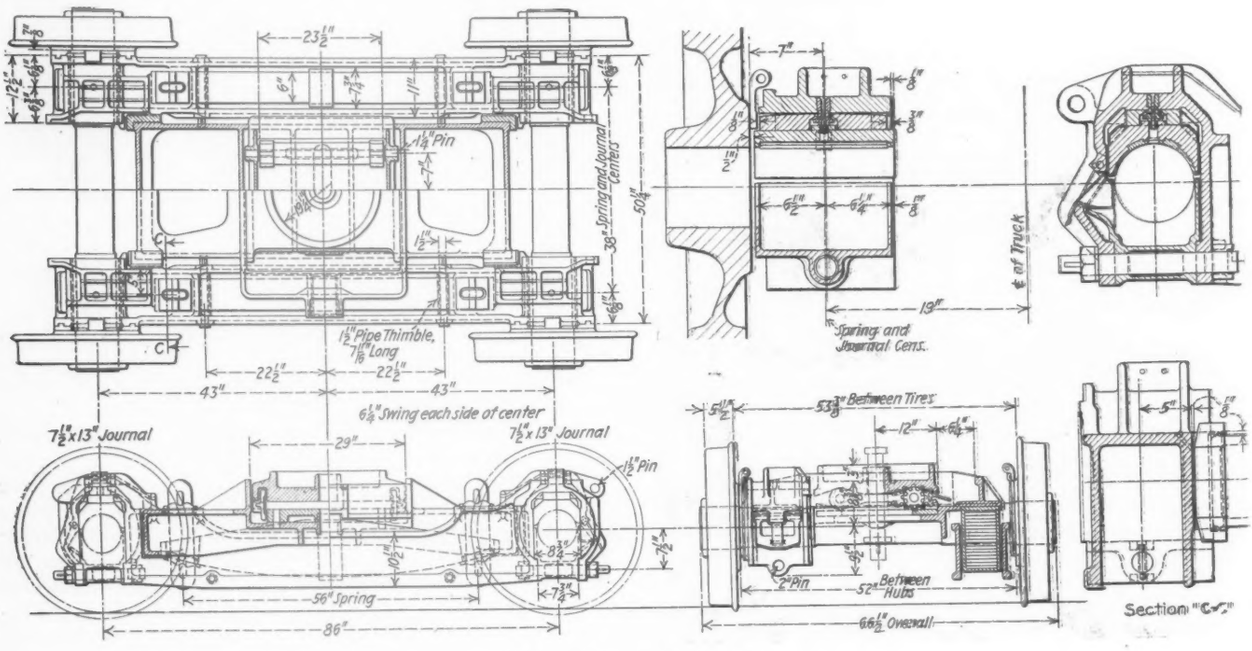


The lateral motion device applied to the front and rear axles

resistance increasing with the amount of lateral displacement. It imposes no excess load on the driving springs and uses a Class G A. R. A. standard car spring to resist lateral motion of the drivers. Referring to the drawing, the rollers, which are 3 in. in diameter, bear against the inner surface of the driving box. Any lateral motion of the drivers is transmitted through the lever of the lateral motion device direct to the resisting spring. When the box is in a normal position in the frame, the rollers are clear of the inner surface which facilitates the work of replacement.

Shown in one of the drawings is the type of driving box applied to the main and crank axles. It is equipped with supplemental bearings below the center line of the axle for the purpose of reducing side wear on the journals. The grease lubricant used in the driving boxes on the crank axles must be applied from the bottom. For this reason, the cellar is made with a drop bottom and the pedestal binder is arched down at the center to allow for the easy renewal of the grease cake. The cellar forms a fixed spreader in the box to prevent any pinching of the sides of the driving box, and also serves as an additional support for the supplemented bearings.

With the exception that the locomotive has an additional pair of drivers, as compared with a 2-10-2 type, and three cylinders, which requires a crank axle on the No. 2 pair of drivers, the side rod design follows the usual practice, floating bushings being used on the main rod bearings. As shown in one of the drawings, the driving, engine truck and trailing truck springs are made with a reverse camber, which is also a standard of the Union Pacific.



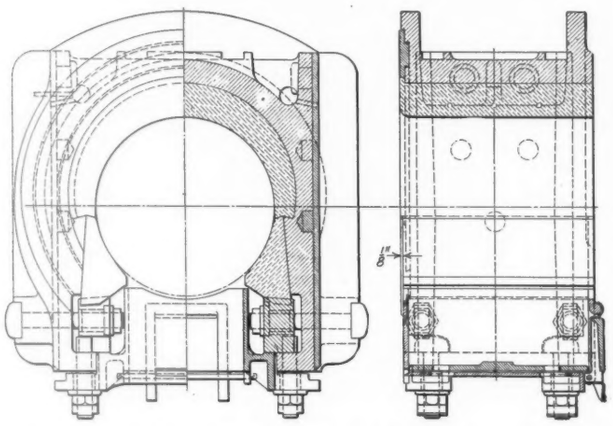
The engine truck details

The engine truck

One of the principal features in the design of the engine truck, shown in two of the illustrations, is the elimination of bolt fastenings. The frame is comprised of three steel castings, two journal box or side frame castings and a squaring frame. Equalization has been secured without the use of equalizers of the usual design. The pedestals have been designed to eliminate wearing

surfaces. Hinged lids are provided at the ends of the journal box castings, as shown in one of the illustrations, which permit the packing and lubricating of the cellars without necessitating their removal. The wheel base of 86 in. permits the use of long, flexible, easy riding springs. The journal bearings rest on a wedge similar to that used in tender journal boxes which insures an equalized journal bearing pressure over its entire surface.

The engine truck hub liners are made in two halves as shown in a drawing and in one of the photographs. The back of each half is provided with a tongue which slopes



Design of driving box used on the main and crank axles

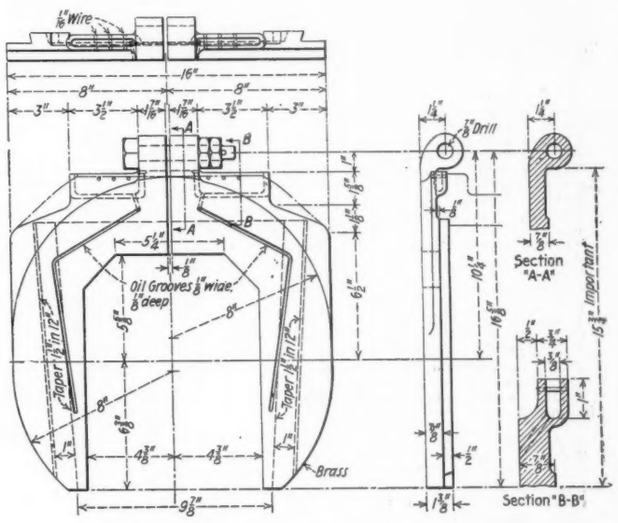
inwardly and down from the top, as shown in the drawing. These tongues dovetail into grooves on the face of the engine truck box which holds the hub liner in position. A bolt at the top secures the two halves together. When necessary to rebabbitt, the halves can be removed by taking out the bolt and can be reapplied without dismantling or removing the truck from the locomotive. Oil cavities are cast in the top half of each liner for lubricating the hub surface. These liners have been tried out on the engine trucks of a number of locomotives for a period of two years and have demonstrated their serviceability and utility from the standpoint of maintenance.

The centering device, shown in one of the engine truck illustrations, permits a swing of 6¼ in. to each side of center. Referring to the illustration, the rollers rest in the vees of the two blocks in the squaring frame casting and the vee block shown at the right sets on the rollers. Each of the two rollers is provided with gears which mesh with the gear teeth at the end of each vee. The latter extend only to the top of the vee which limits the amount of movement of the rollers. The center pin extends down through the vee blocks from the center casting to which the front equalizer is attached, the hole for which is shown in the drawing of the engine truck.

The boiler

The boiler is of the wagon top type and carries a pressure of 220 lb. per sq. in. The firebox total heating surface, including the combustion chamber, is 529 sq. ft. The heating surface of the five arch tubes is 62 sq. ft. making a total fire heating surface of 591 sq. ft. The area of the grates is 108.25 sq. ft. The boiler has 40 tubes, 3½ in. in diameter and 222 flues, also 3½ in. in diameter, with a length over the tube sheets of 22 ft. The total evaporating surface is 5,853 sq. ft. The boiler is equipped with a Type E superheater which provides a superheating surface of 2,560 sq. ft., and a Worthington feedwater heater having a capacity of 10,000 gal. per hour.

The design of the boiler presented a considerable problem. The builders were limited as to axle load and it was also desired to keep the total weight of the locomotive



Details of the engine truck hub liners

as low as possible. To secure a firebox to burn semi-bituminous coal it was necessary to have firebox volume combined with ample length of flameway and depth of firebox. Both volume and length of flameway were secured by a combination of Gaines wall and internal combustion chamber. Previous locomotives equipped with the Gaines wall never had sufficient depth from the crown to the top of the grate, but a satisfactory depth was obtained in this case by allowing the rear driving wheel to extend up between the inside of the throat and the front of

Comparative table of the principal dimensions, weights and proportions of the Union Pacific 2-8-8-0, 2-10-2, 4-10-2 and 4-12-2 type locomotives

Type	2-8-8-0	2-10-2	4-10-2	4-12-2
Cylinders, diameter and stroke	H.P. 26 in. by 32. in. L.P. 41 in. by 32 in.	29½ in. by 30 in.	2–25 in. by 30 in. 1–25 in. by 28 in.	2–27 in. by 32 in. 1–27 in. by 31 in.
Weight on drivers	465,000 lb.	285,500 lb.	288,500 lb.	355,000 lb.
Total weight of engine	495,500 lb.	357,600 lb.	405,000 lb.	495,000 lb.
Length, driving wheel base	15 ft. 6 in. 15 ft. 6 in.	22 ft. 6 in.	22 ft. 6 in.	30 ft. 8 in.
Diameter, driving wheels, outside tires	57 in.	63 in.	63 in.	67 in.
Boiler steam pressure	210 lb.	200 lb.	210 lb.	220 lb.
Grate area	88.1 sq. ft.	84 sq. ft.	84 sq. ft.	108.25 sq. ft.
Total evaporative heating surface	5,412 sq. ft.	5,152 sq. ft.	5,522 sq. ft.	5,853 sq. ft.
Comb. evaporative and superheating	6,809 sq. ft.	6,414 sq. ft.	6,897 sq. ft.	8,413 sq. ft.
Rated tractive force	Simple 123,700 lb. Compound 103,100 lb.	70,450 lb.	78,000 lb.	96,650 lb.
Cylinder horsepower (Cole)	.....	3,136	3,547	4,329
Weight on drivers ÷ total weight engine, per cent	93.6	79.8	71.2	71.75
Weight on drivers ÷ tractive force	Simple 3.76 Compound 4.5	4.05	3.69	3.68
Tractive force ÷ comb. heat. surface	Simple 18.1 Compound 16.9	10.9	11.32	11.5
Cylinder hp. ÷ grate area	.....	37	42.25	39.9

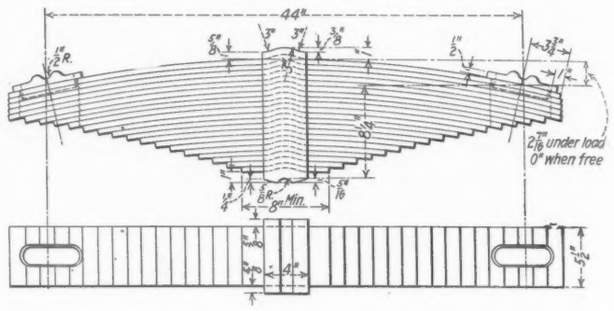
the Gaines wall. It was also desired to retain the same length of tubes, 22 ft., as used on the Union Pacific's other large locomotives, but while this seemingly gives a relatively short tube for a boiler of this size, the long distance from the front tube sheet to the cylinder center should in turn improve the draft conditions in the smoke box by equalizing the pull on the upper and lower flues. The boiler jacket raised for caulking the boiler. This is an improvement over the use of the solid handrail columns which required the removal of the entire handrail before a portion of the boiler jacket could be raised. Handrails used with this type of post are frequently utilized to carry the headlight or train control wiring.

The air compressors are located at the front of the smoke box. This arrangement together with the concealed piping gives the locomotive an unusually smooth appearance. The 67-in. drivers permit the use of a straight axle on the front drivers instead of a bent axle commonly applied to three-cylinder locomotives to clear the inside main rod. Other features in the design are the unusual length of the crown sheet, 241 11/16 in., and the saving in weight, approximately 5,000 lb., through the use of cast steel cylinders.

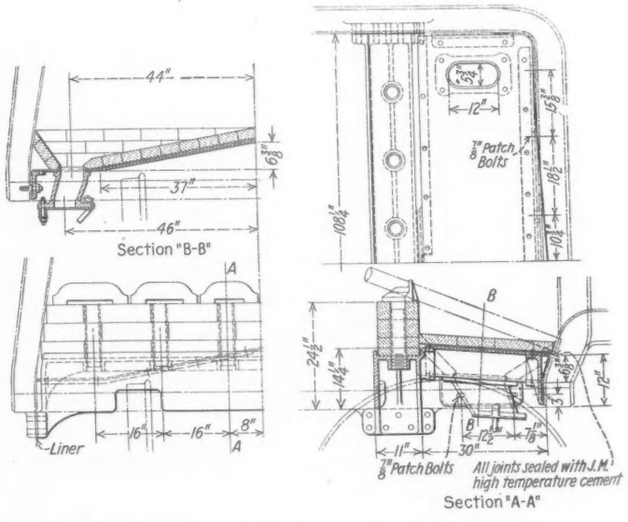
This locomotive was received on the rails of the Union Pacific on April 9, when it was immediately set up and placed in regular service. Since that time it has fully demonstrated that the traction, speed and fuel economy are in excess of the predicted characteristics calculated from the design.

Table of dimensions, weights and proportions of the Union Pacific type locomotive

Railroad	Union Pacific
Builder	American Locomotive Co.
Type of locomotive	4-12-2
Service	Fast freight
Cylinders, diameter and stroke	2–27 in. by 32 in. 1–27 in. by 31 in.
Valve gear, type	Walschaert-Gresley
Valves, piston type, size	14 in.
Maximum travel	7 in.
Outside lap	1¼ in.
Exhaust clearance	1/8 in.
Lead in full gear	1/8 in.
Weights in working order:	
On drivers	355,000 lb.
On front truck	80,000 lb.
On trailing truck	60,000 lb.
Total engine	495,000 lb.
Tender	287,000 lb.
Wheel bases:	
Driving	30 ft. 8 in.
Rigid	17 ft. 6 in.
Total engine	52 ft. 4 in.
Total engine and tender	91 ft. 6½ in.
Wheels, diameter outside tires:	
Driving	67 in.
Front truck	30 in.
Trailing truck	45 in.
Journals, diameter and length:	
Driving, numbers 2 and 3	12 in. by 13 in.
Driving, others	10 in. by 13 in.
Front truck	7½ in. by 13 in.
Trailing truck	9 in. by 14 in.
Boiler:	
Type	Wagon top
Steam pressure	220 lb.
Fuel	Semi-bituminous
Diameter, first ring, inside	90 in.
Combustion chamber, length	80½ in.
Tubes, number and diameter	40–3½ in.
Flues, number and diameter	222–3½ in.
Length over tube sheets	22 ft.
Grate area	108.25 sq. ft.
Heating surfaces:	
Firebox and comb. chamber	529 sq. ft.
Arch tubes	62 sq. ft.
Tubes and flues	5,262 sq. ft.
Total evaporative	5,853 sq. ft.
Superheating	2,560 sq. ft.
Comb. evaporative and superheating	8,413 sq. ft.
Special equipment:	
Superheater	Type E
Feedwater heater	Worthington
Stoker	Elvin
Tender:	
Water capacity	15,000 gal.
Fuel capacity	42,000 lb.
Journals, diameter and length	6 in. by 11 in.
General data estimated:	
Rated tractive force	96,650 lb.
Cylinder horsepower (Cole)	4,329
Speed at 1,000 ft. piston speed	37.6 m.p.h.
Factor of adhesion	3.66
Curvature	16 deg.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cen.	71.75
Weight on drivers ÷ tractive force	3.68
Total weight engine ÷ cylinder hp	114.3
Total weight engine ÷ total heating surface	58.8
Boiler proportions:	
Comb. heating surface ÷ cylinder hp	1.95
Tractive force ÷ combined heat. surface	11.5
Tractive force × diam. drivers ÷ comb. heat. surface	769.7
Cylinder hp. ÷ grate area	39.9
Firebox heat. surface ÷ grate area	4.89
Firebox heat. surface, per cent of evap. heat. surface	6.28
Comb. heat. surface ÷ grate area	77.7



The driving, engine truck and trailing truck springs are made with a reverse camber



Arrangement of the Gaines wall in the firebox

dome is the largest ever built by the American Locomotive Company and the firebox is the largest to which a Gaines wall has been applied.

The handrail post is the American Locomotive Company's standard design and utilizes but one stud to secure the post of the boiler and the cap to the post. This design permits the use of a single length of handrail post throughout the locomotive, since the handrail pipe is applied before the caps are fastened down. By removing the caps from two or more adjacent posts, the handrail posts may be removed without disturbing the hand rail itself and the

The tender

The tender is carried on two six-wheel Commonwealth trucks equipped with 6-in. by 11-in. journals and 33-in. rolled steel wheels. It has a cylindrical tank of 15,000 gal. capacity. The capacity of the coal bunker is 42,000 lb.

The Russian Diesel locomotive, in service in Germany

Diesel locomotive with gear transmission

Electro-magnetically operated clutch system first applied to a Russian 1,200 hp. locomotive

By B. A. Wittkuhus, E.E., and N. Fodor, M. E.*

RECOGNITION is due to Prof. George Lomonossoff and Dipl. Ing. Dobrowolski, whose efforts made possible the building of the first two high powered Diesel locomotives, both for Russia, one already in service and the second recently finished.

The first Diesel electric locomotive, a 2-10-2 type, was equipped with a 1,200 b.hp. M.A.N. Diesel engine and has been in actual service for more than one year. The second Diesel locomotive is a 4-10-2 locomotive with gear transmission system and is also equipped with a 1,200 b.hp. M.A.N. Diesel engine. This locomotive was built by the Hohenzollern Locomotive Works at Duesseldorf, Germany, in collaboration with Prof. Lomonossoff and Magnet-Werk, Eisenach.

This locomotive is designed for freight service. It has the usual European plate frame upon which the Diesel engine is mounted. The castings carrying the Diesel engine serve also for stiffening the frame.

The weight of the locomotive in working order is 275,000 lb. The highest tractive force is 42,000 lb. at 4 m.p.h., and the maximum speed is 34.5 m.p.h.

The cooling system for the water and oil is placed at the front of the locomotive. It is of the fin tube type and is sufficiently large for operation in the warmer regions of Russia. The fan is driven by an auxiliary Diesel engine which is an M.A.N. airless injection, four cylinder, four cycle, single acting Diesel engine and develops 45 b.hp. at 1,000 r.p.m. Through a countershaft the engine also drives an electric generator for the clutches and lighting, and an auxiliary air compressor. The engineman's compartment is situated in this end of the cab. On both sides of the main engine, beneath the platforms, are the fuel oil tanks.

For heating purposes a small steam boiler is provided, which also utilizes the heat of the exhaust gases when the engine is running. The auxiliary cooling water and lubricating oil pumps are driven electrically. A set of storage batteries is placed above the leading truck. The locomotive is provided with Westinghouse brakes, and all necessary devices prescribed for its operation.

The main Diesel engine is of the six-cylinder, vertical, single acting, four cycle, air injection, direct reversible, M.A.N. submarine type and is made of cast steel. The engine develops 1,200 b.hp. at 450 r.p.m. with cylinders of 17¾ in. diameter and 16 9/16 in. stroke.

Two cylinders, each with a cast iron liner, are bolted to a common crank case casting which also carries the main bearings. The air compressors have an independent crank case. These crank case castings are bolted together, thereby forming a rigid girder. Two cooling water pumps and one oil pump for combined piston cooling and lubricating purposes are attached to and driven directly by the engine.

Each cylinder has an independent fuel pump, all of which are combined in a solid block in front of the air compressors. They are driven from the crankshaft. The governing of the fuel pumps and the output of the

* Mr. Wittkuhus is American representative of the Hohenzollern Locomotive Works, Duesseldorf, Germany, and of Magnet-Werk, Eisenach, Germany.

Diesel engine, respectively, is accomplished by changing the closing period of the suction valve.

In order to obtain ignition at low revolutions, the lift of the fuel valve needles is also governed in accordance with the speed and amount of fuel to be injected. The governing of the fuel pumps and fuel needles is interconnected and is done by turning a small hand wheel at the engineman's stand. Compressed air is used for starting the engine, which is done in groups of three cylinders each. An overspeed governor prevents the engine from running above 480 r.p.m.

The trunk piston is made in two parts. The upper which carries the piston rings is of steel, the lower of cast iron. The piston is oil cooled. The cylinder cover is of cast iron and is equipped with two fuel, one exhaust, one inlet, one starting and one safety valve. The exhaust valve is water cooled. Reversing is done by shifting the camshaft, thereby bringing new cams under the rollers, the reversing mechanism being hand driven. The engine has forced lubrication for all moving parts.

The exhaust gases escape through two long cylindrical silencers placed on the roof of the locomotive. This locomotive is the first to be equipped with a gear transmission system in which the speed stages are controlled by high power magnetic clutches. Not very long ago, no one would have believed that any type of friction clutch could transmit such high power as is used in this locomotive in a way reliable enough to warrant the use of clutches on locomotives. Only the recent development in the design and construction of high power electro-magnetically operated clutches made it possible to apply mechanical power transmission on high powered locomotives. The Magnet-Werk of Eisenach, Germany, has already built magnetic clutches for the transmission of more than 20,000 hp. per unit for the power plant of the Badenwerk, Germany, but the main magnetic clutch and the magnetic multiple disc clutches used on this locomotive were the first magetic clutches ever applied to locomotive service. The Magnet-Werk controls the patents on this transmission system. The power transmission system of the locomotive is clearly shown in Figs. 3 and 5.

Keyed to the backward extension of the crankshaft is the main magnetic clutch M (Fig. 5). The power is transmitted by this clutch and by a flexible spring clutch *b* to gears which are located in the gear box, also shown on Fig. 3. This box contains a set of gears for three different speeds and three magnetic clutches.

The main magnetic clutch is constructed of sufficient weight to act as a flywheel for the Diesel engine, and is shown on Fig. 4. It is of the single plate dry friction type but the design differs widely from other magnetic clutches. For the purpose of transmitting the maximum amount of power for its diameter and of giving the minimum wear, it is equipped with an exceptionally large friction lining of special unburnable material. The heat which is developed on the friction surface when the clutch is sliding is negligible and is carried off by the automatic air cooling system of the clutch consisting of radial air gaps between the body of the clutch and the friction plate. Special devices are provided for replacing the friction lining, making it possible to replace it in less than half an hour.

The clutch develops a maximum torque of 220,000 in.-lb. and can be regulated widely. This regulation is necessary at the starting of the locomotive as the clutch must be engaged at first at a low torque in order to avoid shocks when connecting the running Diesel engine with the driving wheels.

The coil of this clutch is specially wound to give high magnetic power with the minimum amount of electric current.

The body of the clutch is manufactured of special soft cast steel with a hysteresis curve which secures the

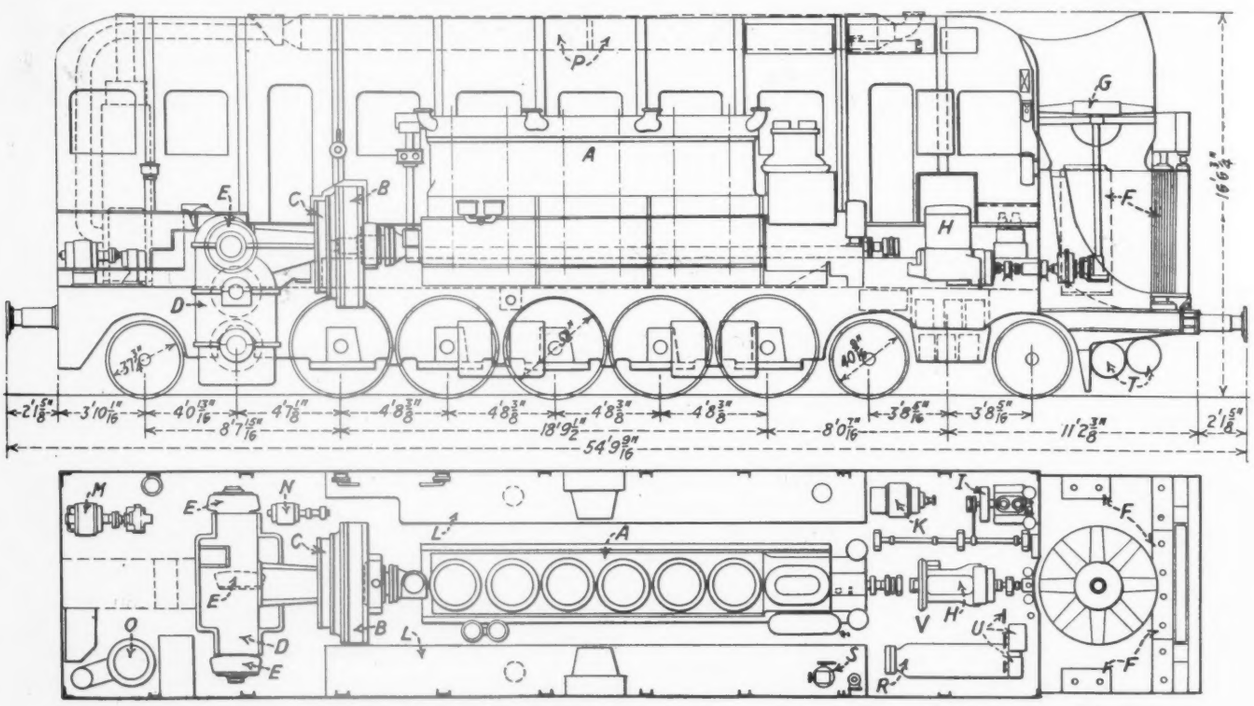


Fig. 2—Arrangement of equipment in the 1,200-hp. Diesel locomotive with mechanical transmission

A—Main Diesel engine; B—Main magnetic clutch; C—Spring coupling; D—Gear case; E—Magnetic multiple disc clutch; F—Coolers; G—Fan; H—Auxiliary Diesel engine; I—Auxiliary air compressor; K—Electric generator; L—Fuel oil tank; M—Auxiliary cooling water pump; N—Auxiliary lubricating oil pump; O—Heating boiler; P—Exhaust silencer; R—Starting air bottle; S—Injection air bottle; T—Air tank for brakes; U—Control devices; V—Engineman's stand.

possibility of gradually increasing the torque when the current is switched on. Further means of regulating the torque are provided by special resistors in the electric circuit of the coil. The torque automatically increases gradually and the clutch slides for a few seconds, thus accelerating the locomotive very smoothly in a relatively short time. The tests on the tracks proved that while starting a 1,500-ton train on a grade of 1.2 per cent, the main clutch slid only 10 to 12 seconds.

The spring coupling is a product of the Fried. Krupp, A. G., Essen, Germany. Its duty consists mainly in equalizing the variable torques of the Diesel engine. This coupling accomplishes its duty so well that the torque at the end of this coupling is very uniform.

The gear system, consisting of a pair of bevel gears and several spur gears, was supplied by the Fried. Krupp, A. G. The gears are of high quality alloy steel, ground and hardened. The shafts are of the best special steel, hardened and accurately ground. The quality of the workmanship in the manufacture of these gears results in an exceptionally low starting resistance and friction loss. An efficiency as high as 93 per cent has been obtained on the test bed with these gears from main clutch to jack-shaft.

The teeth of the gears and the bearings are force-lubricated. The whole system being enclosed in an oil tight and dust proof housing also containing the jack-shaft.

The three speed-stages are controlled by three high powered magnetic clutches, one for each stage. The changing of speed is accomplished merely by engaging and disengaging the clutches, so that the gears are always in mesh, thus lessening the wear of the gears.

These clutches are the most essential part of the whole locomotive and only after years of special experimental and research work, has it been possible for the Magnet-Werk to design these clutches which had to be exceptionally powerful and could not occupy more space and weight than a clutch which, when constructed in the usual way, only transmits about one-tenth of the power of these special magnetic clutches. Their torque is only slightly smaller than the power of the main magnetic clutch but the space occupied by them and their weight is only a fraction of that of the main magnetic clutch. All three are of uniform size and of the multiple disc, dry friction type and are shown on Fig. 6.

These clutches will probably never need any adjustment or replacement of friction linings as they practically never slide and therefore have no wear. They have been constructed to engage instantly after the current is switched on. The consumption of electric current by the clutches is very small and does not exceed 1.3 kw., including the main clutch. Only one of the multiple disc clutches and the main clutch are engaged at the same time, the other two being idle.

The total weight of the gears, clutches, jackshaft and housing is 30,800 lb. The gear system has the following ratios:

Through clutch I and gears 1, 2, 3, 4 the ratio is 1:7.
Through clutch II and gears 5, 6, 3, 4 the ratio is 1:4.
Through clutch III and gears 7, 8, 3, 4 the ration is 1:2.

In addition to these gear ratios, the revolutions of the Diesel engine can be changed to such an extent that the revolutions of the driving wheels vary between 14.5 and 225 r.p.m., corresponding to a speed of from 2.25 to 34.5 m.p.h. The reversing of the locomotive is accomplished by reversing the Diesel engine.

There is one control-lever for the Diesel engine, one controller of the drum type for the main clutch and one similar controller for the three multiple disc clutches, the lever of this latter controller having three positions for the three speeds. The operation of the locomotive is accomplished as follows:

After starting the Diesel engine and accelerating it to its idling speed, the engineman engages clutch I by moving the control lever to the position for speed I. Upon receipt of the starting signal, he engages the main clutch *M* gradually by means of the main controller. After a few seconds, during which the main clutch slides, the train starts to move and accelerates. Further accelerating is made by speeding up the Diesel engine to its maximum revolutions. As soon as this point is reached, the engineman removes the lever of the controller for the three multiple disc clutches to the position of the second speed, thus disengaging clutch I and engaging clutch II. Automatically, by moving the lever, the torque of the main clutch is decreased for a few seconds by varying the resistance of its electric circuit

Fig. 3—The 1,200 hp. Diesel locomotive without the cab, showing the mechanical transmission at the right

thus enabling the main clutch to slide for a short time if the respective speeds of Diesel engine and gears do not correspond exactly. After changing the speed, the Diesel engine which has been slowed down, is again accelerated, and the same operations are repeated for changing to the third speed.

In this locomotive the three different control levers have been provided to permit a study of the relations between the three different controls, with the ultimate purpose of designing a simplified one-hand control with which a locomotive of this type will be equipped.

The Diesel locomotive with gear transmission system maintained a brake thermal efficiency from 30 to 31 per cent. This is 20 per cent more than the efficiency of the 1,200 hp. Diesel electric locomotive. It is to be borne in mind that the geared-driven Diesel locomotive operates

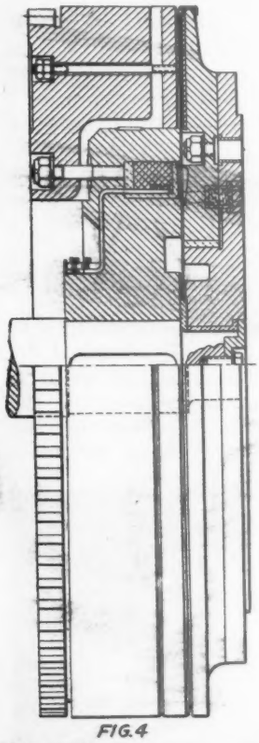


FIG. 4

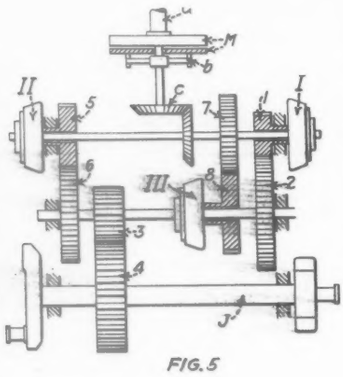


FIG. 5

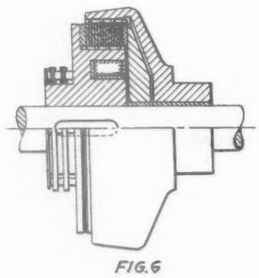


FIG. 6

Fig. 4—The main magnetic MWE clutch; Fig. 5—Scheme of the clutch and gear transmission system; Fig. 6—Magnetic MWE multiple disc clutch

with this high efficiency almost on its entire power range, while the steam locomotive maintains its maximum efficiency during limited periods only.

Fig. 7 shows that the same Diesel locomotive if equipped with four proper speed stages can be used easily for freight or switching and passenger service. Neither an electric locomotive nor the other existing transmission systems can render the same kind of railway service. By simply varying the gear ratios, the tractive efforts and speeds can be easily adjusted to different conditions.

We wish to mention a few advantages of the geared Diesel locomotive. The passenger locomotive having a high tractive force first stage gear can be used for terminal switching service also, thereby eliminating special switching locomotives. This same locomotive, on account of the high tractive force of the first two stages can be advantageously used for freight service, the remaining speed stages being arranged for high speed passenger service.

The possibility of thus using one Diesel locomotive for different purposes will result in reduction in the number of locomotive types, standardization of locomotives and Diesel engines on a large scale, and lessening the cost of operation, maintenance, and production.

The design of the locomotive also makes possible the arrangement of multiple unit control.

Doubts may arise regarding the smooth starting and acceleration as well as the flexibility of a Diesel locomotive employing a gear transmission system.

The locomotive has been subjected to thorough and extended tests on the locomotive testing plant in Dussel-

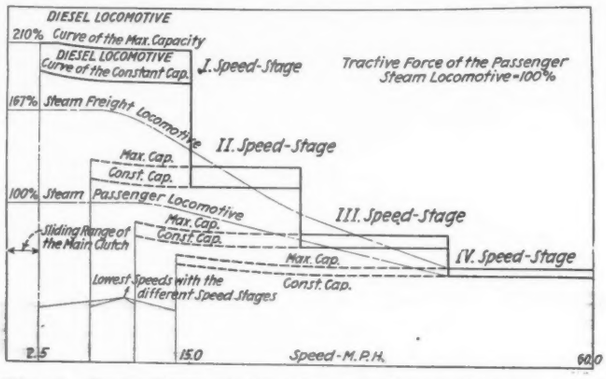
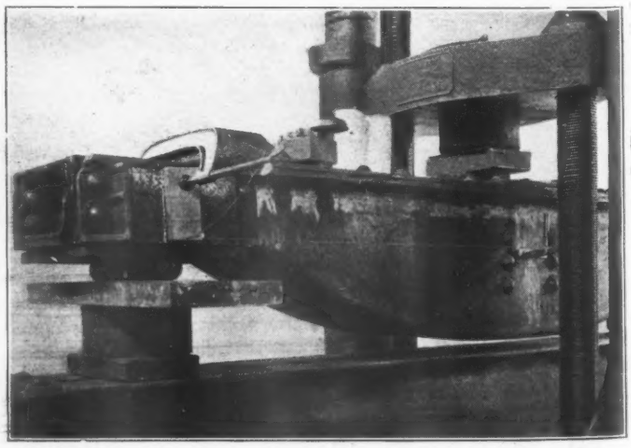


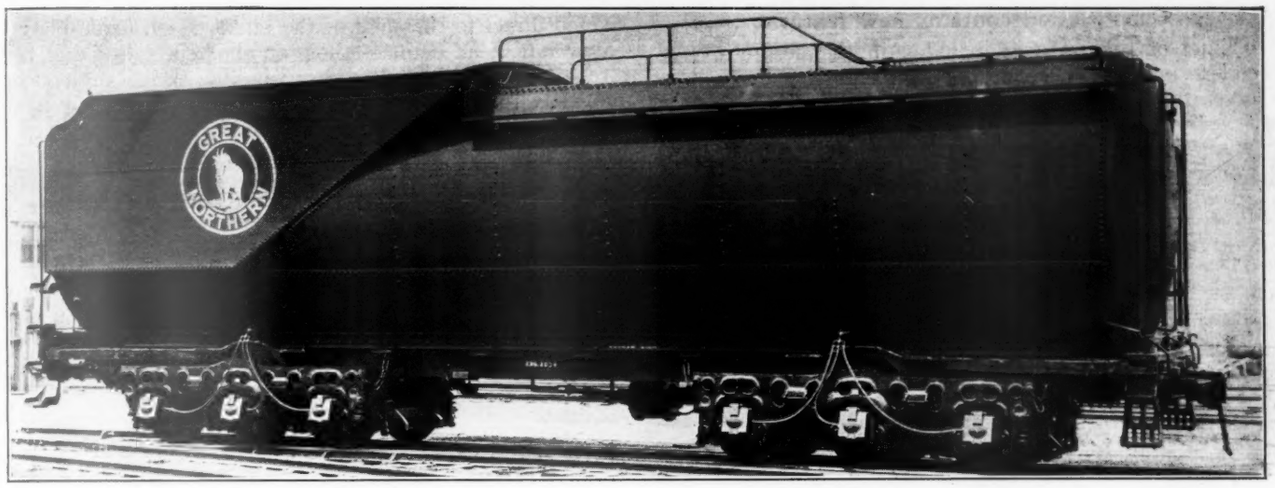
Fig. 7—Comparison of the form of characteristic curves of steam and Diesel locomotives, the latter with a four-speed mechanical transmission

dorf. Since May 1 it has also undergone tests on the tracks of the German State Railways.

It has been ascertained during these tests that the locomotive starts smoother than a steam locomotive, even with heavy trains on grades. The control of the clutches as mentioned above has proved entirely satisfactory and the speed changes are accomplished without the slightest shocks. After 2,600 miles in heavy freight service, and more than 1,000 main clutch operations, the wear of the friction lining of the main clutch was found to be .011 in. Thus with a variable speed Diesel engine and properly selected gear ratios, the Diesel locomotive with gear transmission system meets every requirement of flexibility in modern railway service.



Bending tests of a pressed steel car truck bolster on a 300,000 lb. capacity Riehle machine at Purdue University

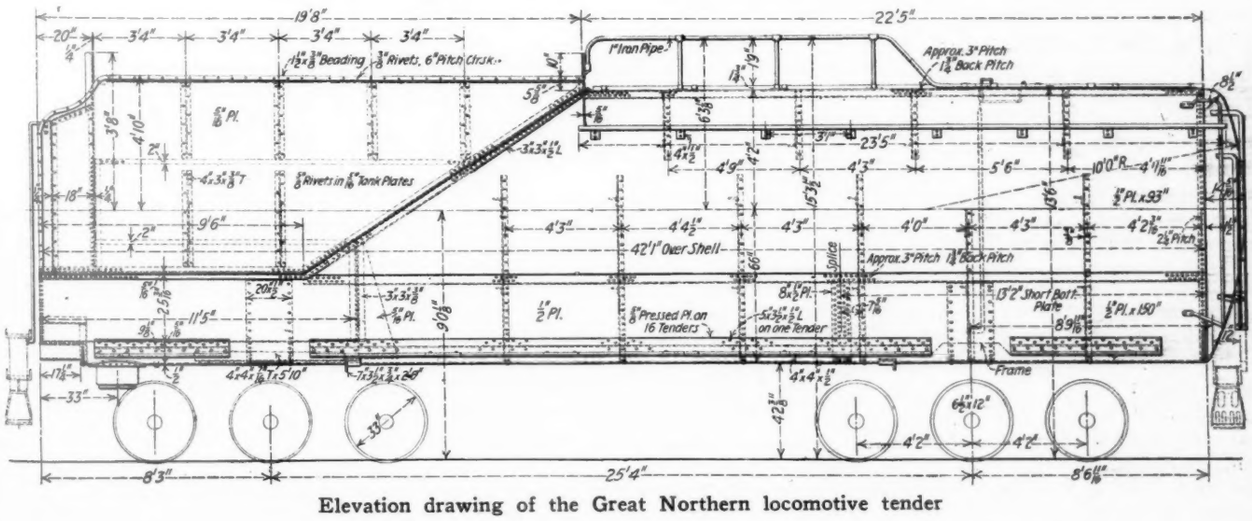


Vanderbilt type tender built for the Great Northern by the General American Car Company

Tenders of large capacity for the Great Northern

Rigid anchorage between body and underframe—Capacity 24 tons of coal, 21,500 gal. of water

THE General American Car Company, Chicago, is delivering an order of 17 locomotive tenders to the Great Northern which are the largest that have ever been built for regular railroad service. These tenders have a coal capacity of 24 tons and a water capacity of 21,500 gal. The light weight is 138,100 lb. and the weight when loaded is 364,550 lb., or 182 tons. The length over the striking castings is 44 ft. 7⅝ in., and the distance between truck centers, 25 ft. 4 in.



Elevation drawing of the Great Northern locomotive tender

These tenders are the result of extensive studies made by the management of the Great Northern of its operating problems with the object of obtaining more efficient operation, especially on grades over the Rocky Mountains, and the purchase of these tenders is an interesting development not only in the type of tender construction, but also in the procurement of increased operating efficiency for heavy tonnage trains. The introduction of large capacity tenders will make possible considerable reduction in operating time and costs and also permit closer adherence to schedules. Many stops for fuel and water can be eliminated, thus permitting heavy trains to make continuous hauls over difficult divisions. Stopping trains shortly before reaching a water tank or fuel station, uncoupling the locomotive, filling, returning to the train, coupling and testing the air before proceeding, takes considerable time. The elimination of such stops, of course, enables a train to get over the road much faster and with fewer interruptions to it and following trains.

Construction contains new features

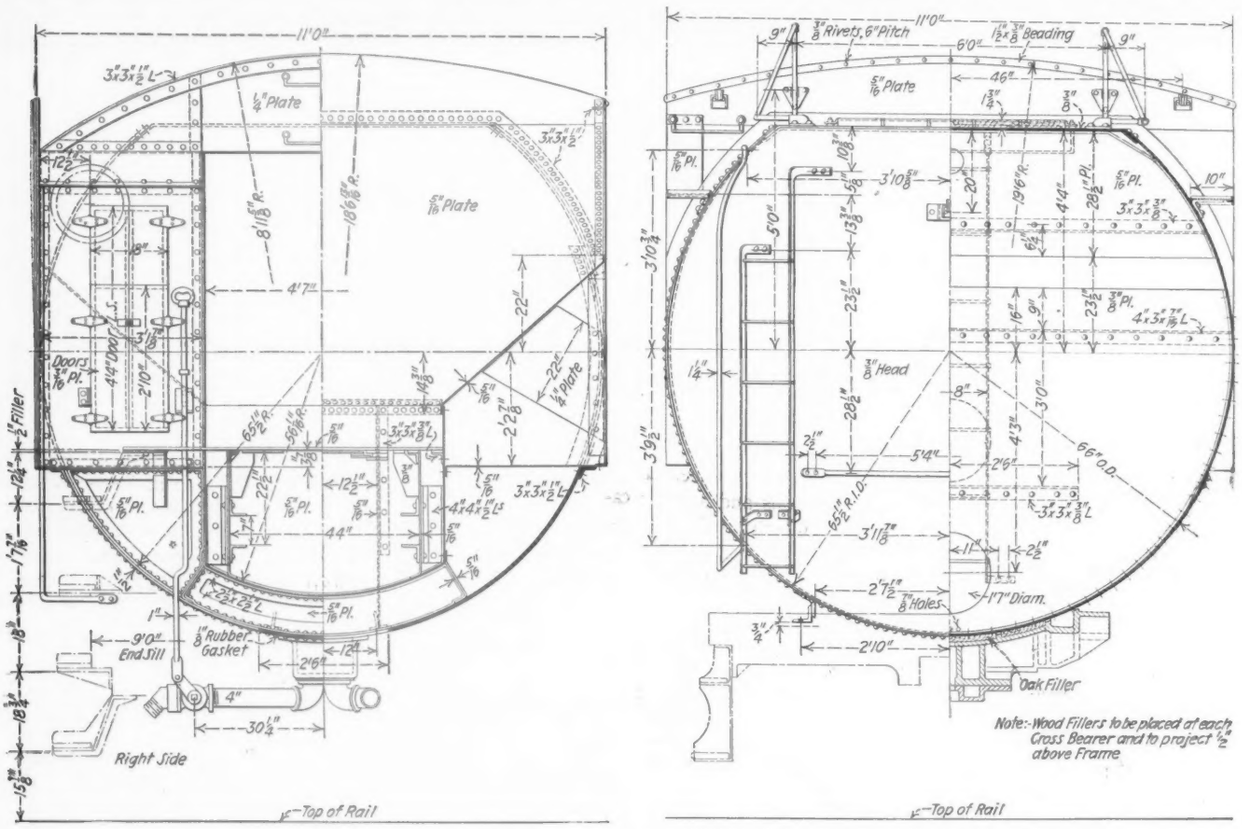
Some of the features included in the design of the tenders are the result of developments that have been successfully used in tank car construction for a number of years. The engineering department of the General American Car Company, which has had considerable experience as designers and builders of large tank cars, was able to render valuable assistance to the mechanical department of the railroad in developing the design of these tenders.

A feature in the design is the use of the General American type of rigid anchorage between the tender body and the cast steel underframe. This is a patented device for use in tanks for transporting liquids and has proved quite satisfactory after many years' service. It consists of a longitudinal angle riveted to the tank body with the other flange punched to register with another angle, one flange of which is riveted to the angle on the tank and the other flange bolted to anchorage pads cast in the underframe. This anchorage runs practically the entire length of the tank on each side and permits a wide distribution of the stresses incident to operation and end shocks. It is also located for ease in application, inspection and maintenance, permitting the anchorage bolts to be kept tight at all times with the minimum amount of labor.

Previous practice on this type of tender tank has been to rivet the anchorage castings on the tank, which fitted on pads cast on the underframe, several pads being distributed along the side of the tank, but this set up localized stresses and sometimes resulted in buckling the plates to which they were attached.

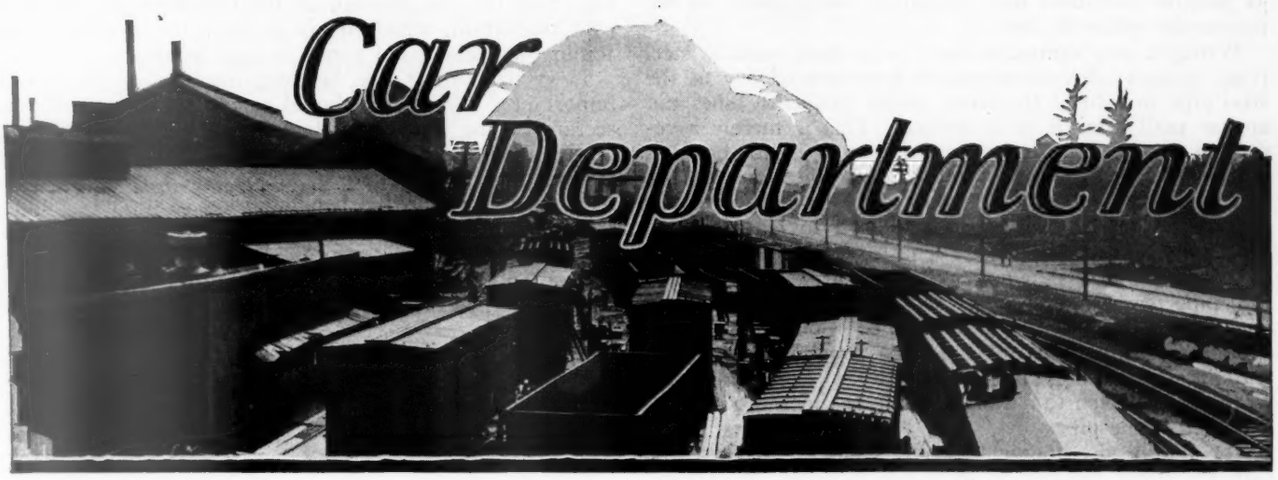
Referring to the elevation and cross section drawings, it will be seen that the tank is provided with six baffle or surge plates, the edges of which are flanged and riveted direct to the shell of the tank. Each baffle plate has a 1-ft. 7-in. diameter hole on the center line and is strengthened with a 3-in. by 3-in. by ⅜-in. angle, as shown in the cross section drawings. The holes in adjacent baffle plates are placed in vertically staggered position to each other. In addition to the bracing provided by the baffle plates, the top portion of the shell is braced with ⅜-in. plates and angles as shown in the elevation drawing.

The height from the rail to the top of the hand rail is 15 ft. 4½ in., to the top of the running board 13 ft. 4 in., and 9 ft. ⅜ in. to the horizontal center line of the tank. The underframe is a single steel casting, designed and cast by the Commonwealth Steel Company, St. Louis, Mo. The six-wheel truck frames are of the Commonwealth cast steel integral pedestal type, equipped with 6½-in. by 12-in. journals, 33-in. rolled steel wheels and clasp brakes. Besides the special equipment already mentioned, the tender is equipped with a Miner draft gear, friction side bearings, 12-in. by 18-in. air brakes, Imperial type A uncoupling device and two vertical built-in tool boxes.



Cross section drawings showing the design of baffle plates and bracing used in the construction

2-8-0 locomotive built for the Cerro de Pasco railroad, Peru, by the American Locomotive Company



Report of the air brake convention

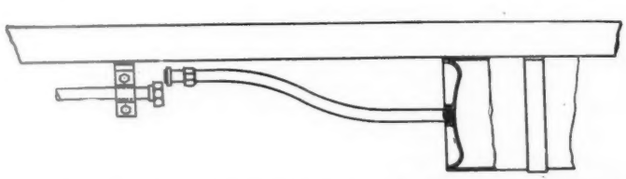
Papers on insulating air compressors, air brake hose coupling gages and threading and bending air brake pipes

A BRIEF account of the proceedings of the opening sessions of the thirty-third annual convention of the Air Brake Association, which was held at the Hotel Roosevelt, New Orleans, La., on May 4 to 7, inclusive, appeared on page 374 in the June issue. Before the close of the convention, the association voted to hold its 1927 convention at Washington, D. C.

In the following pages will be found abstracts of two reports and one paper, most of which have an important bearing on the maintenance of air brake equipment.

Threading and bending of air brake pipes

It must be borne in mind that as wrought iron pipe has been selected for air brake service because it has better welding quality, better threading quality, superior resistance to corrosion, and especially its superior resistance to shock and vibration, certain limitations of the material, or points of difference in comparison with steel, must be given consideration in its use. Some of these more important points are considered below.



An example of poor alignment of pipe in fitting which results in a strain being placed on the threads of the reservoir connection when the pipe is sprung into place

Methods of bending pipe

In making a bend, there is stretching of the metal on the outer circumference of the bend, and a tendency for compression on the inner circle. A neutral circle, or axis where no elongation or contraction takes place, lies somewhere between the inner and outer circles. Experience indicates that in cold bending, the neutral axis lies close to the inner circle; in other words, practically all of the metal is stretched, with greatest amount of stretch on the outer circle; and consequently almost all of the pipe wall is thinned to a greater or less degree. In hot bending, the neutral axis appears to be somewhat closer to the inner circle than to the outer; ordinarily about one-third of the distance out from the inner circle. Thus for hot bends, the inner one-third of a pipe wall is thickened; while the outer two-thirds are stretched and thinned.

The ability to make a bend, other things being equal, depends upon the ability of the pipe metal to stretch. For any given size of pipe, the ratio of stretch required to complete the bend increases as the radius of the bend decreases. For a fixed radius of bend, the outer stretch is more severe as the diameter of pipe increases. Hot bends can be made to shorter radii than cold bends; this is because the ductility of the metal is greater when hot than when cold; also because the neutral axis is farther out and the total stretch around the outer curve is therefore less.

If pipe is permitted to flatten or collapse during bending, the outer circumference is lessened, and the bend is more safely made. On this account, the sand filled bend puts more strain on the metal than one made without filling. Of course, sand filling results in a superior type of bend, and one retaining the full pipe bore.

Extra heavy pipe is preferable to standard weight for bending, because when stretching takes place, the pipe wall does not so soon reach a thinning to the danger point of tearing; also there is more effective wall thickness left for service.

To make short radius bends, the closest attention must be given to all details. Proper workmanship is as important as quality of material, for poor workmanship can spoil good as well as poor pipe.

Since the best of practice does subject the larger portion of the metal to a stretch, the method should so far

as possible distribute this elongation evenly over the entire section which is bent.

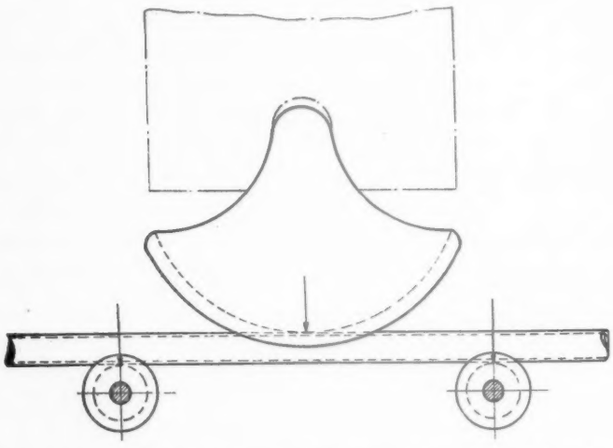
Wrought iron cannot be bent to as short radii as steel pipe; however there is always a greater tendency of the steel pipe to split at the weld, which frequently does not appear until after it is in service. This is merely a reflection of the fact that wrought iron does not have as much ductility as steel. Standard specifications of the two materials require a minimum ductility of twelve per cent for wrought iron pipe, compared to eighteen per cent for steel pipe, in a gage length of eight inches.

Experience has shown that a good grade of wrought iron pipe may be safely stretched cold twenty to twenty-five per cent in each one-inch zone. Consequently for average grade of material and good practice, cold bends without sand filling may be made with extra heavy wrought iron pipe to a radius of three times the outside diameter of the pipe.

For hot bends, double the cold strength above noted may be safely reached in each one-inch section, before tearing occurs. Consequently unfilled hot bends may be made with extra heavy wrought iron pipe to a radius of one and one-half times the outside diameter of the pipe.

If tearing occurs in making certain bends, it is well to check the amount of stretch and its uniformity by prick punching the unbent pipe at one-inch intervals along the line of the outer circumference of the bend. After bending, the elongation in the individual inches may be measured with a flexible scale. It is not unusual to find that bends which apparently should not tax the pipe severely, are up to or exceeding the danger limits in certain sections of the bend, due to faulty practice. It is obvious that uniformly distributed stretch is an important factor in making short radius bends.

In hot bending, it is exceedingly important to get the proper temperatures. Maximum ductility is reached at about 1,500 deg. F. (a cherry red heat). This temperature should not be exceeded, because the ductility of the

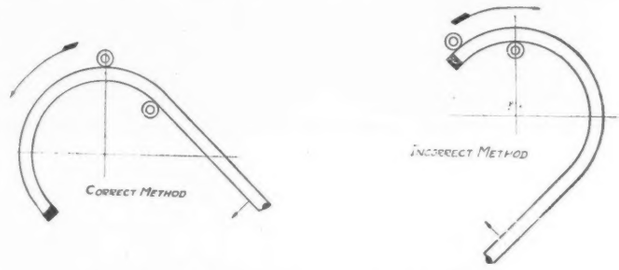


Drawing illustrating an unsatisfactory method of bending pipe in a bull dozer

wrought iron falls off rapidly with further increase of temperature. Also because there is a peculiar condition of relative strength which causes an abnormal condition in stretching. It is equally important to heat the pipe uniformly to the proper temperature over the entire zone covering the complete bend.

Conditions and practice for hot bending must be more carefully controlled than for cold bends, because of (1) the ease with which more than normal distortion may be accomplished; (2) the adverse influence of uneven heating; and (3) the absence of the compensating effect of cold overstrain, which tends to shift the stretch to adjoining less elongated zones in cold bending.

Next to heating, the bending machine or practice is important. The stretch should be applied to a small local section of the bend, and then by proper functioning of machine or practice this stretched zone should be advanced out of the sphere of action and a new adjoining section subjected to the bending force. Forcibly pulling a clamped pipe around a sheave or pin, or pushing it into form in a bulldozer, represents probably the poorest method and puts the most severe strain on the pipe. The general method of using the bulldozer type of bending is



Correct and incorrect method of bending pipe

illustrated. Where the die presses against the pipe, in making the bend, a binding action occurs at both pins or rollers; this binding or pinching action becomes more pronounced if the rollers fit the pipe poorly or are not free to rotate. Because of this the pipe is not free to movement and there is always a strong tendency to localize the stretch of bending in the portion of the pipe between the rollers. Careful or skillful hand bending, or proper construction of machines, work towards the desired end.

Slow pulling of the bend is of considerable advantage. The fabricators, who regularly obtain good results, with wrought iron, employ machines which progressively advance the bent section, and subject the following unbent portions to the forming action and without further strain upon the bent section. In some hot bending cases a stream of water is applied to the outside circumference in the zone of progressive bending. This stiffens the already stretched metal, concentrates the stretch on the following hot and unbent portions of the pipe, reduces collapsing, and tends in some degree to bring compression on the inner circumference more into play in formation of the bend. This practice is not recommended except with most skilled operators, and best of machines and practice.

More difficulty will be encountered in bending galvanized pipe than for similar work on black pipe. This usually is confined to outcropping of trouble in occasional pieces, and is probably due to some embrittling influence of pickling.

The position of the weld in bending is usually a cause for argument. With highest quality of welds, this matter is of relatively small amount. In general, it is advisable to have the weld on the outer circumference. This is particularly true for butt-welded pipe; and the same rule is not out of place for lap-welded pipe.

While the points outlined above apply to bending practice in general, many of the cautions are especially applicable to short radius bends. Too much stress cannot be laid upon the advisability of avoiding short radius bends as far as possible; and it is believed that in railroad service, half to three-fourths of the customary short bends may be eliminated. The shorter the radius of the bends, the greater the proportionate stretching. Many extra

heavy pipe installations are actually of less than standard weight thickness in the close bend section.

It hardly seems necessary to stress the often repeated warning to thoroughly clean out piping before installation, especially after undergoing a bending operation. Nevertheless we are all aware of the fact that this is too often neglected, not only by the railroad shops but also by the builders in turning out new equipment. This neglect invariably leads to additional expense caused by the necessity of removing valve devices for supplementary cleaning and for carrying out the belated cleaning of the piping, when the rolling stock is first received from the shop doing such work.

Accurate smooth threads essential

In order to insure a good tight joint between the pipe and fittings, it is necessary to have a clean smooth cut thread of the proper shape and taper; and to secure such a thread, it is necessary to keep dies and machinery which do this work in proper condition.

In the use of hand-tools, and especially the narrow receding chaser types of today, it is very important that the die stock be clamped to the pipe securely in order to obtain good results. A small wrench or plyers should be used upon the thumb screws.

Wavy threads are very often the result of not having the die stock securely tightened to the body of the pipe. Also while a very good appearing thread may be obtained, it is possible that the threaded end may not be perfectly round, thereby causing a leak when screwed into a fitting, and especially so when used in connection with air brake piping.

It is very important that the thread on the pipe be long enough to insure a full engagement of pipe and fitting. If full engagement is not obtained, loose or leaky joints are apt to result; and more than that, vibrational stresses, instead of being distributed over the entire thread bearing, are localized in the two or three engaged threads, which frequently result in premature failures.

In this connection, it should be remarked that the fitting is frequently improperly tapped and will not permit of a full thread engagement. When a fitting of this kind is encountered, it should either be retapped or scrapped. There is no excuse for supply concerns furnishing such fittings, because pipe threads are standardized with definite allowable tolerances both for the pipe and the fitting. These tolerances are so designed that the maximum of one ought to properly make up with the minimum of the other, and when this cannot be done with a properly threaded pipe, the fitting is non-standard and should not be used.

Of all the economic crimes committed by pipe fitters, that of straining into position pipes that must come together but through faulty practice are not properly fitted, is the most common and the most expensive. Pipe may be well bent and threaded, and joints carefully made, with little assurance of long life if an initial strain is thus needlessly placed on the threads of some connection. Inspectors should be instructed to break a union here and there on new work, and if the pipe springs to one side, they should refuse to approve the job until the pipe is correctly fitted. This will save a lot of money.

The general features brought out in this paper are an endeavor to briefly convey suggestions of the best practices to get the greatest efficiency in pipe installations. There are limits beyond which material cannot be safely used. Good workmanship in fabrication is an important factor in getting the maximum out of any pipe. In railroad service, in particular, initial stresses set up by straining joints into place due to faulty alinement, improper bending, or poor threading, will accelerate fatigue failures and reduce the normal margin of safety in train operation.

(This paper was contributed by the Pittsburgh Air Brake Club.)

Air brake hose coupling gages

A major portion of brake pipe leakage is due to hose couplings. The Committee on Air Brake Hose Couplings has made a number of tests on eastern and western railroads and finds the present standard A. R. A. gages are not applicable for removing couplings that are not fit for service. In a large number of cases, couplings that pass the present standard A. R. A. gages could not be made tight under pressure after the renewal of gaskets.

The following information developed:

Forty-seven per cent of the couplings examined were found to have the diameter of the hole too small to admit

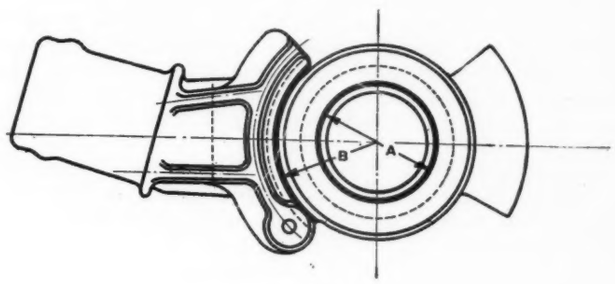


Fig. 1

the application of a standard A. R. A. gasket properly, as shown in Fig. 1, dimension *A*.

Sixty-eight per cent of the couplings examined showed that there was a variation in distance from the center of the bore to the outer edge of the guard arm from 1/32 in. to ⅛ in., resulting in the impossibility of proper alinement of two couplings, as shown in Fig. 1, dimension *B*.

Forty-one per cent of the couplings examined showed that there was a variation in the distance of the top face of the gasket groove from the face of the coupler, as shown in Fig. 2, dimension *C*.

Eighty-six per cent of the couplings examined showed

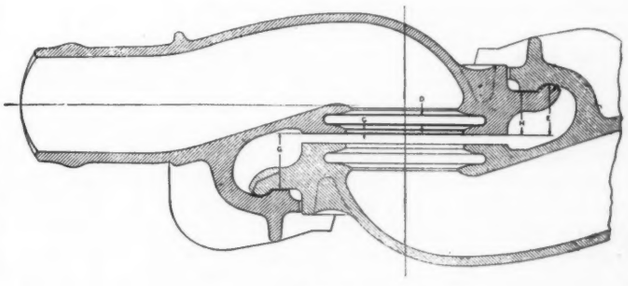


Fig. 2

that the gasket grooves were not in accordance with A. R. A. standards; there being a considerable variation below the minimum and above the maximum allowed, as shown in Fig. 2, dimension *D*.

Forty-three per cent of the couplings examined showed a variation in the bend of the lip of the coupling. The height of this bend is important in order to permit the coupling to come in contact with the flat bearing face on lip and guard arm, in order to produce the proper amount

of resistance in the coupling against pulling apart, as shown in Fig. 2, dimension *E*.

Seventy-one per cent of the couplings examined showed that there was a variation in the contour of the body of the coupling. This contour acts as a guide when coupling the heads, and insures proper alinement of the gaskets.

Fifty-seven per cent of the couplings examined showed that there was a variation in the grooves and flat spots on the guard arm as shown in Fig. 2, dimension *G*.

Fifty-four per cent of the couplings examined showed that there was a variation between the face of the coupling and the flat bearing face of the lip. This distance controls the compression to which the gaskets are subjected, when the couplers are coupled, as shown in Fig. 2, dimension *H*.

On account of the wide variations from permissible tolerances of couplings, as made by various manufacturers, and further, realizing the inadequacy of the present A. R. A. gages, your committee feels that improvement of the gages is necessary, and that closer inspection by manufacturers and railroads should be insisted on. Since the angle cock is the greatest offender in producing brake pipe leakage, and is closely seconded by the coupling, any efforts to reduce the leakage from these points is well worth while.

(The report of the committee was signed by Chairman R. M. Long (P. & L. E.), L. G. Plank (Penna.), W. Shriver (B. & O.), J. P. Stewart (M. P.), and J. H. Glenn (P. & W. Va.),

Insulation of air compressor steam cylinders

By C. B. Miles
New York Air Brake Company, Omaha, Neb.

At the Los Angeles convention, in the concluding paragraphs of the paper on "More Efficient Air Compressors" we called attention to the unnecessary waste of energy through the exposed walls and heads of the steam cylinders of locomotive air compressors. At that time we had in mind running a test to measure this loss, but a change of position prevented our pursuing this interesting problem to a conclusion. It is obvious to the student of air brake problems that this heat waste can be materially reduced by insulating the cylinder surfaces in a more complete manner than is done at present.

The walls and heads of the 8½ in. 150 cu. ft. compressor represent in excess of 3,400 sq. in. of radiating surface, a part of which, about 38 per cent, is covered with sheet metal and generally a wooden lagging. It appears very important to pay attention to radiation losses where steam is being used expansively, as is the case with this type of compressor. In the second stage, or low pressure cylinder, there is a definite measure of steam at reduced temperature to do a certain amount of work. As much of this energy as possible should be used to propel the piston, rather than lose itself through the walls and heads of the cylinder.

If the piston speed is high there are more measures of steam to suffer loss. If the speed is reduced, the time element comes in, and it is problematical, under certain conditions, as to whether the piston makes a full stroke or not.

This compressor is properly designed for economical operation, but the steam cylinders cannot be water jacketed and expect the best performance which we are just about doing when we are fanning these exposed surfaces with the equivalent of a 60 mile an hour zero breeze.

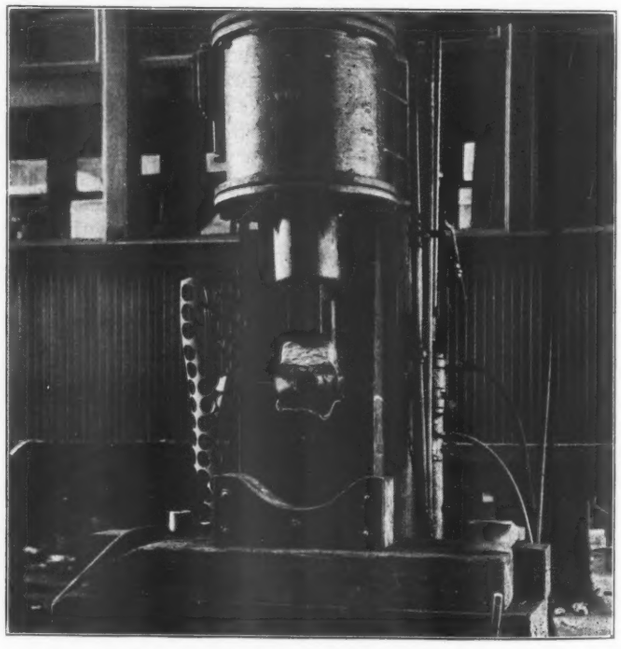
If the regular service efficiency could be increased five per cent we would be the gainer just that per cent of the cost of whatever amount of compressed air is necessary. The average one thousand engined railroad could take the $10,000 saved from that source and reduce their $200,000 brake system leakage cost to $66,000 (which is the mark the Brake System Leakage Committee sets up for us to hit), with the expenses of a well equipped air brake supervisory organization paid for in advance.

The Union Pacific through the interest taken in this subject by O. S. Jackson, superintendent, motive power and machinery, have made some preliminary tests, to which they attach sufficient importance to have more thoroughly covered the steam cylinders on compressors on the last engines ordered, and the advisability of going further with this arrangement hinges on the saving effected as against the price of the job.

We hope the convention will deem it proper to cause to be investigated: The efficiency lost from radiation; the most effective and economical method of lagging; the efficiency loss from initial low pressure; smaller steam line and governors than recommended, and the efficiency loss from exhausting against back pressure.

A Convenient pipe bender

A CONSIDERABLE amount of pipe bending is required in connection with repairing air brake equipment on passenger and freight cars. This work can be made much easier and speeded up by the judicious location of pipe bending machines such as shown in the illustration. It consists of a 12-in. air brake cylinder and a substantial



An inexpensive pipe bending machine

work table, both bolted to one of the building columns. The forming dies used on the end of the cylinder piston rod are made from iron or steel, while the dies used on the table are made of wood reinforced on the sides with metal plates. The fact that the cost of making these dies is small, permits the machine to be equipped to bend most any curve in a pipe of any size common to railway cars.

Construction and maintenance of cars*

Proper design, stability of employment and location of shops and facilities important factors

By L. L. Yates

General superintendent car department, Pacific Fruit Express Company

THE advance made in the last quarter century, in railway equipment and its attendant construction and maintenance facilities is immensely greater than in all preceding time. Volumes could be written on the subject of car construction and maintenance, each requiring a specialist in some particular line. The subject is so broad, involving such a diversity of experience, knowledge and training in each of its branches, that no one man is qualified to do it justice except in a general way and therefore we must confine ourselves to a few outstanding high lights common to all branches, leaving the detail to be filled in by the individual imagination.

Primarily the railroads are in the business of transporting freight and passengers, a service which they render the public for remuneration and profit. The profit is small compared with the extremely large volume of business. It is plainly seen then that there must be a well balanced ratio between earnings, investment and maintenance to produce the profit to which the roads are entitled.

Investment does not fluctuate and can justly be considered as the center of the balance while earnings and maintenance at either end of the beam must be carefully watched.

Importance of proper car design and maintenance

Properly constructed and maintained equipment has a direct bearing on economical investment and maintenance costs and railroad service can not be sold profitably except as such is the case.

Car movement, organization of shop personnel, location and arrangement of shops and yards and efficient, adequate shop machinery and tools are the four most important factors in the construction and maintenance of railway equipment.

To construct a thing cheaply it must be made in large quantities; likewise minimum repair costs are contingent upon quantity. Car movement, then, is the center about which the whole program revolves and an element beyond control of any shop or maintenance force. The movement of cars is most active when business, industry and agricultural enterprises are prosperous. During such periods we find extensive programs for the construction of new equipment and repair facilities, but generally speaking maintenance work is at a standstill because equipment can not produce revenue on a repair track. On the other hand when there is a general depression and conditions are not so prosperous there is a large quantity of idle equipment which, if it were economically possible to transport to repair points, its maintenance could be carried on in the most efficient manner. Under such an ideal condition shop forces could be organized to best advantage, repair work properly classified and parts produced in the most economical quantity.

Organization of shop forces and personnel is the second important factor which is too often overlooked, not alone by railroads, but by others as well. Steady permanent employment produces an ideal condition never to be hoped for while there is such a wide fluctuation in car movement through repair points.

The selection of efficient workmen and leaders is no small task; for example, during the world war 1,700,000 men representing a fair sample of the population of the United States were examined as to their mental efficiency. Of these, ten per cent were so low in the mental scale that they were unfit for soldiers. The demands of a railroad upon the individual are quite as severe as those of the army.

When railroad employment is steady and permanent, the workman finds himself surrounded by a favorable environment, and under constant and careful supervision and training more efficient results can be attained. Often such conditions are overlooked by the employee and in times of business activity he has a disposition to move about, due to restlessness under the necessary discipline of organization and he is often tempted in a baseless hope of betterment.

Labor turnover is not altogether a responsibility of the railroad. It is one of the phenomena of prosperous times.

Proper location of repair points and arrangement of facilities

The proper location of repair points and the arrangement of yards, buildings and machinery is such an elementary phase of the subject that a layman is qualified intelligently to enter the discussion from a standpoint of the ideal. However, most of us who have been connected with railroad service for a lifetime cannot point, except in rare cases, to an ideal shop arrangement or location. Traffic, available property, and land values are to be considered in the selection of a shop location.

Repair points of any consequence must necessarily be located near some large terminal towards which the largest number of cars move under load. Such locations permit empty cars to pass directly through the shop for thorough inspection and repair before distribution for reloading. Shops located along the seaboard render it possible to maintain a constant supply of cars through the repair shop with materials at a minimum cost. It is obvious then that property so located is high in value, the shop location where available space permits is not always best adapted to the purpose. Under such circumstances cramped conditions result, reflecting high repair costs all the way through the shop operation, a condition over which there is almost no control.

* Abstract of paper presented recently before the Pacific Railway Club, at San Francisco, Cal.

There is considerable which could be said about the proper arrangement of shop buildings and stores of repair material. Also ample trackage laid out in such a manner as to facilitate the classification of cars under repair, permitting the utmost ease in transferring cars from one point to another with the least switching expense and without fear of jamming the yard.

Continuous, progressive movement of raw materials to the manufactured car part, passing through the shop in one direction is of importance in keeping down the shop costs. When shop buildings and material stores are advantageously arranged, material handling expense is at its minimum. Handling and storage of materials is one of the largest of shop expenses when you stop to consider that one and one-half carloads of manufactured parts are handled to make one complete car of the refrigerator car type. Handling costs are the lowest when the materials are handled the least number of times.

What has already been said about the arrangement of buildings and stores is likewise true of the arrangement of machinery within the buildings.

When we speak of adequate shop machinery and tools we should never lose sight of the word economy.

Construction and maintenance of railway equipment and the upkeep of shop facilities calls into play almost every class of mechanical operation.

Machinery and tools are required which are in constant operation day in and day out while others are either engaged for short periods or are provided for the sake of convenience. Shop superintendents, foremen and workmen very often overlook the fact that idle machinery never assists in lowering manufacturing costs.

Many times there is a tendency to manufacture parts which outside manufacturers could supply at less or no greater cost. Assuming that the price is reasonable it would be better policy to purchase such parts from outside concerns who specialize and produce the article under the supervision of trained experts and who have the best machinery adapted to the purpose. Experiments are costly except that it is definitely known that the article can be produced and economy effected.

Another factor in low car construction and maintenance costs is the concentration of workmen performing identical operations. Keeping a workman continuously busy on one operation to which he is thoroughly trained and limiting the area over which he operates is of great importance.

Repair work should be thoroughly done

What has previously been said deals largely with conditions over which the construction and maintenance organization may or may not have control. There are, however, many minor factors in maintaining equipment over which the organization can exercise perfect control. For instance each unit whether it be man, machine or building can perform its work thoroughly enough to keep the equipment on the road and not in the shop. Equipment must be repaired and maintained but the extent of maintenance is directly governed by the quality of work performed.

Carelessly constructed or repaired equipment causes no end of trouble and expense in train operation once it is loaded and on the road. A repair costing but a few cents at the shop can cause several hundred dollars in train delay if failure occurs but a few miles away.

Important points to watch when repairing refrigerator cars

In the construction of the refrigerator car it is eminently necessary that more care be given than in the construction of other freight equipment. It is first necessary to select the best of the materials, particularly in the superstructure, which as you know, is the only part of the car that materially differs from other freight cars.

The lumber must be well seasoned to prevent shrinkage when framed and assembled. The efficiency, quantity and application of the insulation is of the utmost importance, and has caused more thought than any other one feature entering in the construction of the refrigerator car. It will readily be seen, on account of the belt rails, sills and carlines, the difficulty encountered to maintain the continuity of the insulation, which is highly desirable.

Particular care is taken in the application of the insulation to the car, to see that it is not only securely applied, but all parts protected, and vertical dead air spaces frequently blocked to prevent circulation within the walls, which, if not prevented, would assist in the absorption or radiation of heat.

The insulation in the floor of the car, which by the way is highly important, is more susceptible to damage or deterioration due to the misuse of equipment, such as driving nails or spikes into the floor to brace load, loading ice or commodities requiring ice in packages, and other commodities which later require the washing of floors, with the result that moisture will penetrate the insulation, affecting not only its efficiency as an insulator, but also the floor timbers, causing rapid decay or deterioration.

The floor insulation itself should be as near waterproof as practicable, without impairing its efficiency as an insulator, and when applied should be well coated with an odorless waterproofing compound, with a melting point of not less than 175 deg. F. and must be pliable at zero—highly adhesive when hot and not sticky when cold. This requirement is necessary to meet the extremes of temperature to which these cars are subjected. This waterproofing compound should be liberally used around side walls at the floor line to prevent capillary attraction in the side wall insulation.

Side and end sills should be thoroughly coated after framing, with red lead and oil, or some other preservative of equal merit.

It is also necessary to minimize, if not entirely eliminate the use of bolts through the insulation, as they afford direct channels for the transmission of external temperatures.

The main floor should be of select vertical grain lumber, with edges laid in white lead and oil and coated with raw linseed oil. Other parts of the interior of the car, should receive one coat of raw linseed oil and two coats of waterproof varnish. The floor, side and end lining around ice bunkers should receive a coat of mineral paint carrying high percentage of raw linseed oil to prevent decay from condensation.

There are approximately 140,000 refrigerator cars in the United States, the majority of which have been constructed in recent years, and are built in accordance with recognized designs, suitable for the business for which they are intended. There are, however, many older cars that are receiving general repairs to make them conform to modern methods of construction.

Methods of repairing refrigerator cars

The Pacific Fruit Express Company owns and operates in excess of 33,000 refrigerator cars of the most modern type, and to maintain them in a high state of efficiency, each car as it returns to California after a trip east, before being placed for loading, as a rule passes through one of our shops, whether or not it is

in need of repairs, where it receives the most careful inspection by specially trained men, and any defects discovered are plainly marked with chalk and written up on inspection card which is placed on the car door. Following these inspectors, are repair men, who are trained and skilled in their respective crafts making any repairs necessary. Car cleaners thoroughly clean the ice bunkers and the body of the car, and if the car contains oil spots or other foreign matter requiring washing, this work is done by another class of workmen. Interior walls and the ceiling, if in need of revarnishing, are attended to by painters.

After all this work has been performed, inspectors make an after inspection to see that the repairs have been properly made and that the car is in safe and serviceable condition, particular care being given to the side doors to see that they are perfectly tight. The side doors are then closed and sealed with a heavy wire, and the ventilators set in an open position, permitting thorough ventilation.

This work is all performed in what we classify as the light repair yard. Any cars requiring extensive repairs are switched to the heavy repair yard, or reconstruction shed where we employ men specially skilled in the art of rebuilding refrigerator cars, where any of the wood parts or insulation showing decay is removed and replaced with new material, special care being given to the renewing of insulation in a workmanlike manner to see that the vulnerable points are protected. This work is under the supervision of foremen who have had years of experience in refrigerator car maintenance, and who are cognizant of the functions of the refrigerator car, which are considerably different from other types of cars.

No doubt you are all familiar with the location and volume of perishables shipped from Pacific Coast points, which include California, Oregon, Washington, Idaho and Arizona and the West Coast of Mexico, rendering it impossible at all times to pass cars through our main shops, in which event we have inspectors and repair men at the principal loading centers to clean thoroughly and make minor repairs and on cars requiring heavy or general repairs, they are forwarded to one of our main shops.

In view of the fact that thousands of carloads of perishables are hauled annually from Pacific Coast points in Pacific Fruit Express equipment, it necessarily follows that each of its 33,000 cars receives inspection and repairs an average of seven times a year which aids considerably in reducing car failures.

The construction and maintenance of railway equipment, like most other things of this day and age, does not escape the study of the technical mind. Members and various parts are theoretically designed to withstand certain forces. These members must be connected to one another. Rivets are the usual connecting medium. The designer is staking his whole computation on careful riveting and it is obvious what occurs when defective rivets are driven merely with the intention of plugging a hole. What applies to rivets equally applies to welding and blacksmith work.

Consideration must also be given to cleanliness and the proper care of scrap and usable materials not particularly from the standpoint of general shop appearance, but because workmen can perform their work more efficiently when an orderly condition prevails in the shop.

In conclusion let us bear this thought in mind; that it is our first and foremost duty to keep the equipment on the road, in which event the other troubles will care for themselves.

Cause and prevention of hot boxes*

By A. G. Hill

Foreman, car department, F. W. & D. C., Ft. Worth, Texas

JOURNAL boxes run hot from various causes. The principal defects are inferior material used in journals, journal brass and journal brass lining; worn and untrue wedges; untrue seats in the journal boxes; missing and worn dust guards; inferior packing; lack of proper lubrication; hard spots in journal brass lining; untrue journals; worn fillets and worn collars, and cracked lining or a broken brass. A broken brass is usually caused by the brass being too narrow or too small for the journal, causing it to spread and break in the center, resulting in a hot box. All brasses should be checked before they are lined to see that they are the proper size. Linings should be of the proper thickness and checked again to see that they are of the proper dimensions. Lining should be free of all blow holes and should be tight in the brass, as a loose lining in running warm on a bearing will often turn out of the brass, causing a hot box. Blow holes often have small shavings in them, or a cinder, or a grain of sand will get in the hole and cause friction which results in a hot box and often a cut journal, resulting in the expense of changing the wheels, as well as delaying the car and lading. It also causes unnecessary switching and usually a disatisfied patron. The relining of journal brass in the ordinary railroad shop is false economy. One reason for this is that it is generally thought that most any coppersmith helper or apprentice can do the job. The lining is usually melted from the old brass which has more or less scrap metal, sand and cinders in it and is not properly skimmed. This sediment in the lining causes hot boxes, as the lining is not properly poured in the brass. Burned babbitt and babbitt not properly mixed leaves hard and brittle spots, this also causes hot boxes.

Inspection of journals and brasses should be given close supervision before applying, to see that the journal is in perfect condition and free from all pits, scales and cuts; that the journal does not have high and low spots or any hard or crystalized spots, and that the brass has a perfect fit on the journal. The inspector should also see that no dirt, grit or waste is left on the journal before the brass is applied and that the wedge is in place and fits the brass and box. After doing this, pack the box in the following manner: Take new, or properly renovated packing, make a plug and insert it in the back of the box. The ends of the plug should be well pointed. Tamp tightly, so the plug seals up the opening in the box, to prevent dirt or any foreign matter from getting in and also to prevent the oil from running out. Then apply the packing loosely out to the collar and half way up the journal. Make another plug, insert it down in the box with one side of it under the collar extending up to the center of journal, tapering it down at 45 deg. and out to the end of the box. Then apply a little oil to insure prompt lubrication as the journal warms up.

This is the time to fight the hot box and if the above plan is carried out in applying wheels, you will have no hot boxes off your repair tracks.

Proper inspection of journals and brasses as well as packing is made in the following manner: First, examine the wheel and if oil has been running out on the wheel, this is a sign that the box has been giving trouble, or is going to. As a general rule the appearance of oil on a wheel indicates that the packing was not shoved back to

* Abstract of paper read at the April meeting of the Texas Car Foremen's Association, Fort Worth, Texas.

make a close fit around the shoulder of the journal so as to lubricate the journal and seal up the opening of the box. Then open the box lid and if the journal looks black or the packing is dry, examine the journal with a sharp pointed hook. If the journal is rough or cut, the box should be jacked, the brass removed, and the brass and journal given a thorough inspection to locate the trouble. Apply the necessary remedy, which is usually a new brass and packing and in many cases, shopping for a new pair of wheels.

There are other causes for journal boxes running hot, such as rough handling in switching, knocking brasses and wedges out of place and the brass jumping up so that waste grabs get under the brass. Any of these will cause a box to run hot very quickly. Sometimes trainmen derail cars out on the road and the brasses are turned over or otherwise thrown out of place. This causes hot boxes. Many times the train crews do not report a derailment in order to avoid explaining how it occurred.

Protector for paint sprayers

THE growing use of paint spraying machines has confronted the railroads with the problem of adequately protecting the workmen against the fumes and mist of paint thrown off during the operation. To protect the workmen against this undesirable menace, many types of masks have been devised. The chief objection to many of them has been that they are too

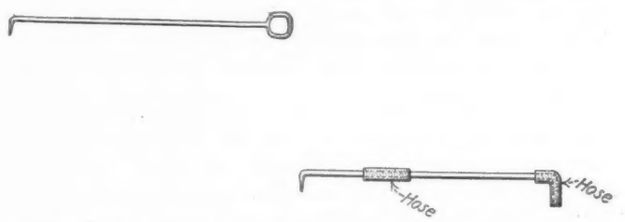
Painter fully protected for paint spraying

heavy and bulky for complete comfort to the painter. The protector shown in the accompanying illustration is not only light in weight but serves the dual purpose of guarding the painter against the paint mist and of protecting his clothes. It is made of heavy canvas, stitched up the sides, with an air opening at each side at the top. The operator looks through a 6-in. by 8-in. glass set in a metal frame. This protector is simple to make, at a minimum cost.

Improved hook for removing journal packing

By Jos. C. Coyle

AN oiler at the Denver & Rio Grande Western car shops, whose job it was to remove the packing from the journal boxes of cars being rebuilt, found that the packing hook used tended to paralyze his right hand, by cutting off the circulation. This was because the ring shaped handle of the packing hook had evidently been made without a thought of comfort or efficiency. A few moments at the blacksmith shop, together with the use of a sharp pocket knife and a discarded piece of hose, soon changed the tool into a handy one, with a comfortable piston grip. It was found that the improvement greatly



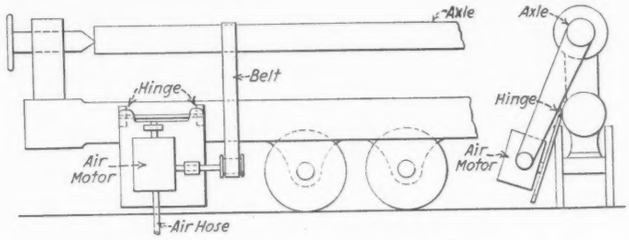
The old style packing hook is shown at the left, the improved hook at the right

facilitated the work and protected the workman's hands from harm.

After reshaping the handle of the hook, which was made of a 3/8-in. steel rod, an air hose was cut to a suitable length and simply slipped over the handle, the crook holding it firmly in place. A second section of hose was slipped on the rod from the point which made a sliding grip for the other hand.

Device for revolving axles on a straightener

SHOWN in the sketch is a device for revolving axles on a Watson-Stillman axle straightener which is being used in the wheel shop of the Lehigh Valley at Sayre, Pa. The use of this device has eliminated the services of an extra man for this job, all of the work of axle straightening now being performed by one man. Referring to the sketch, an air motor equipped with a flange belt motor is secured to the carriage of the axle straightener by means of two hinges. A belt is passed



Sketch showing the application of an air motor for revolving car axles on an axle straightener

around the axle and pulley of the air motor, the weight of the motor keeping it taut. The axle to be straightened is placed between the centers as shown. As the air motor revolves the axle on the centers, the operator takes a piece of chalk and marks the part of the axle which turns out of line as it revolves. The chalk marks enable the operator to tell at just what points the axle needs to be straightened and it can be used as a guide when the axle is placed between the dies of the machine. This operation can be repeated at any time during the straightening process so that it tends to provide greater accuracy in straightening axles.

Progressive car repairs at Little Rock

Material delivered to fixed stations and cars moved from station to station—Marked reduction in cost effected

IN the freight car department of the Missouri Pacific shops at Little Rock, Ark., the progressive system of freight car repairs has been adopted with excellent results in the reduction of rebuilding costs. In connection with the progressive system, a scheduling and routing plan similar to that employed in the locomotive department of the same shops has also been adopted in this shop.

In the rebuilding of freight cars under the progressive system, the material is delivered in advance, the cars to be repaired being stripped in the yard. Such parts as are reclaimable are reclaimed and delivered to their respective positions on the repair line. The trucks are rebuilt on an inbound truck track. The endeavor is to keep trucks for 25 cars constantly in advance of the car men.

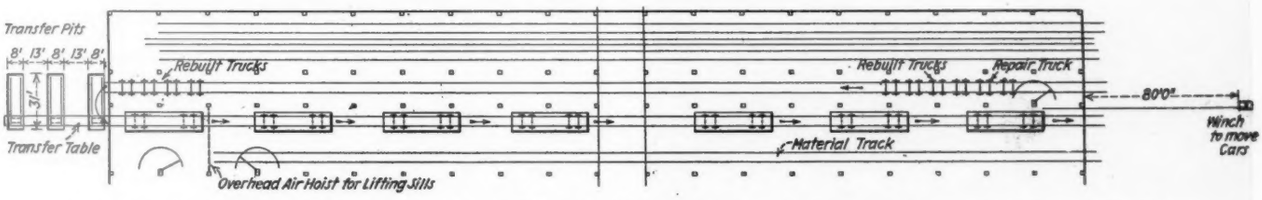
As the trucks are completed, they are moved across a transfer table so constructed as to carry either single trucks or a complete car body from which it has been found unnecessary to remove the steel center sill.

These cars then start on their movement down the erection track, and progress in specified moves from position to position, with the material for each operation stored immediately adjacent to the position concerned. In repairing flat cars, the operations on which are here described, a move is made every 45 min., and 10 cars a day are turned out. The work performed at each station is as follows:

First operation, Stripping and dismantling cars,
12 Laborers.

Second operation, Rebuild trucks,
2 Truckmen
3 Helpers

Third operation, Apply draft arms to center sills, stake pockets to side sills, assemble center sills to truck bolsters.
4 Carmen
2 Apprentices

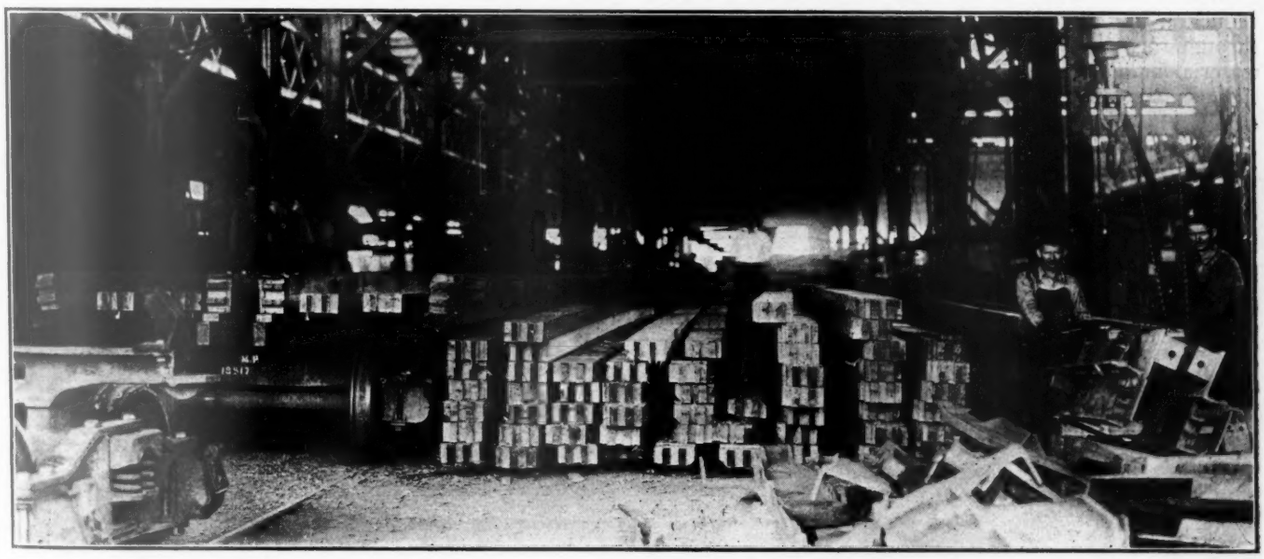


Progressive method of handling and rebuilding freight cars at Little Rock, Ark., on the Missouri Pacific

Fourth operation, Bolt down side and center sills, apply subsills, crossties and cylinder blocks,
5 Carmen
2 Apprentices

Fifth operation, Apply end sills and truss rods,
4 Carmen
1 Apprentice

Sixth operation, Apply couplers and outside brake beams,
2 Truckmen
2 Helpers



Second operation—Assembling sills, draft arms and stake pockets

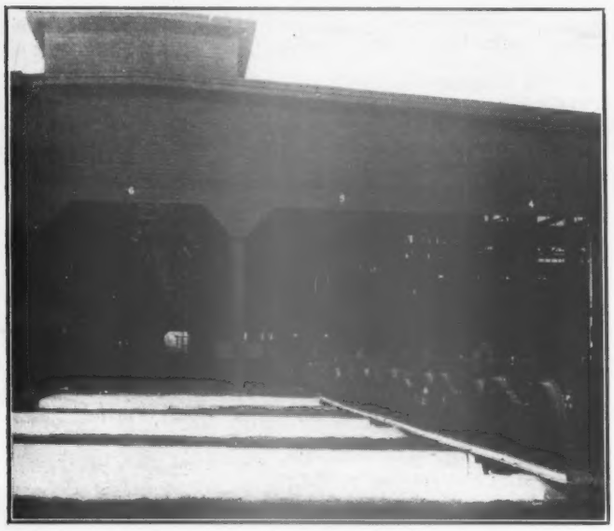
Seventh operation, Apply safety appliances and air brake,
3 Carmen
2 Apprentices

Eighth operation, Lay and spike decking,
2 Carmen
1 Helper

Ninth operation, Paint and stencil,
1 Painter
1 Helper

The total man-hours consumed per day per car are 38.4. With the present number of men, however, it is felt that three laborers can be removed from the stripping gang, and with the receipt of the Dayton spike driver for nailing decks, one man can be removed from this operation.

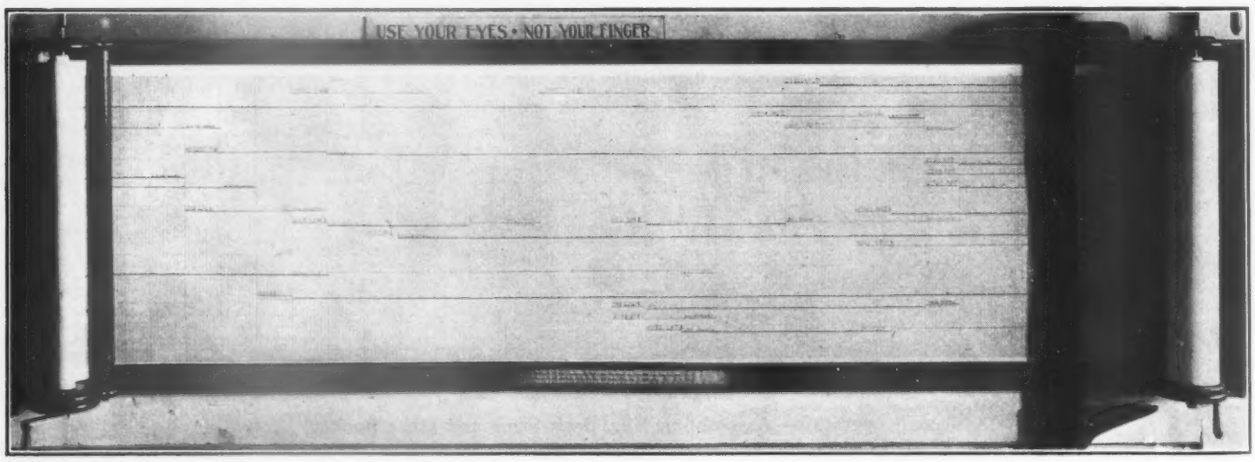
The handling of material from the wood mill to the freight car shop operates on schedule to insure prompt delivery and eliminate any delays. The old method of building freight cars by delivering the necessary material to each car where it was jacked up on the line was costly. A cost check at this time reveals a 38 per cent reduction in the cost of rebuilding cars, brought about through installation of facilities for promptly handling material and elimination of hand labor wherever possible; such as conveniently located air hoists, air drills and reamers, motor-driven socket wrenches, car pullers, etc.



Truck transfer table for moving repair trucks to the erection track

One of the features of the scheduling system which is applied to both passenger and freight car repairs at the Little Rock shops is the master progress chart of new design. This chart is so constructed that it operates on rollers carrying a continuous roll of drawing paper 20 in. wide and 50 yards in length. This permits the carrying of a two years' record of performance for reference, visualizing complete data, such as the "in shop" date, the scheduled date out of shop, and the actual date of delivery, together with clear indications of any departments responsible for delays incurred during the shopping period. The progress is indicated by a line, in a single color if the progress is normal, but in a changed color at any time that a delay is experienced in the scheduled progress of the work. This color indicates the departments responsible for the delay. A more complete description of the scheduling system, as it is applied in the Little Rock locomotive shops, will appear in a later issue.

The tenth or final operation of stencilling



Freight car progress board at the Little Rock, Ark., car shops

---

Cost of fuel in 1925.—The average cost of coal to the railroads in 1925 was $2.72 per net ton, as compared with $3.03 in 1924, according to the Interstate Commerce Commission's monthly statement of the cost of fuel for road locomotives in freight and passenger train service (charged to operating expenses) for Class I roads, not including switching and terminal companies. The cost ranged from $1.78 in the Pocahontas region to $4.66 in the New England region. In December the average cost of coal was $2.63, as compared with $2.83 in December, 1924. The roads consumed 97,477,842 net tons in 1925, as compared with 97,917,613 in 1924, and the total cost of coal was $264,747,386, as compared with $296,790,900 in 1924. The average cost of fuel oil for the year was 3.13 cents per gallon, as compared with 2.78 cents in 1924, and the roads used 65,277,735 gallons, as compared with 58,355,823 in 1924. The total cost of coal and fuel oil for the year was $330,025,121, as compared with $355,146,723 in 1924.

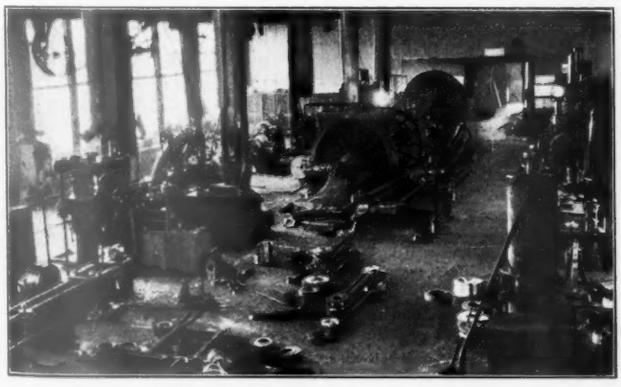
Pennsylvania East Altoona engine terminal

Over 200 freight locomotives turned daily—Method of handling work on sidings and in house

Part II

A WATER pumping station and three large storage tanks are located along the west section of the enginehouse. The largest tank has a capacity of 183,000 gal., while the two smaller tanks each have a capacity of 35,000 gal., which gives a total water storage of 253,000 gal.

The power plant located at this point supplies the enginehouse layout with hot and cold water, steam, air, electricity and hydraulic pressure, as well as air to the classification yards.



A general view of the machine shop looking towards the blacksmith shop

Storage sidings

The storage sidings are located just east of the enginehouse, one on each side of the layout. The siding on the northern side is for west bound power which has a storage capacity for 75 locomotives and that on the south side is for east bound power which has a storage capacity for 60 locomotives. Each storage siding has two work pits approximately 200 ft. long, where underneath repairs are made. Each siding is provided with an emergency service building containing necessary tool equipment, oil supply and working material stock bins. A main service building is located at the west bound siding. This contains an office for the supervision and clerks and a complete set of piecework charts for use in connection with the work originating on the storage sidings.

A corner of the machine shop, showing a group of the engine lathes

An emergency hospital car is located just west of the

service building on the east bound siding. This car is fully equipped with 20 hospital cots, a stove, sterilizer, surgical instruments and medical supplies. All accidents occurring anywhere in the enginehouse layout are first treated in this car. One of the clerks working in the main office has received instructions from the local hospital as to the proper way to give first aid to all classes of injuries.

A 110-ft., three-point suspension turntable is located at the extreme eastern end of the engine terminal. This

The inspection pits looking toward AL tower at the western end of the layout

table is used to turn the power before it is placed on either of the two storage sidings.

Organization of employees

The figures for the month of December, 1925, show that a total working force of 1,134 men were employed at the East Altoona terminal. Table II shows the distribution of the working force according to tricks and crafts. During the first trick, 566 men were employed of whom 229 worked in the enginehouse and 283 on the outside; during the second trick, 311 men were employed,

The blacksmith shop

142 of whom were in the enginehouse and 159 on the outside; during the third trick, 257 men were employed, of whom 81 were in the enginehouse and 163 on the outside.

There were ten gangs in the enginehouse during the first trick; seven of these were machinist gangs, two were boilermaker gangs, one was made up of carpenters and tender repairmen and one was the boilerwash gang; during the second trick there were five gangs, four of which were machinist gangs and one a boilermaker gang; during the third trick there were two gangs made up of machinists, boilermakers, pipe fitters, etc. During the first trick one of the machinist gangs is known as the miscellaneous gang, which repairs feedwater heaters, stokers, gage cocks, water columns, piston packing and inspects wedges and the locomotive machinery. These men are all specialists in their work.

On the outside of the enginehouse there are 12 gangs on the first trick and eight each on the second and third tricks. These gangs are located at the locomotive storage sidings, ash pits and inspection pits.

Space will not permit the analysis of the duties of each gang at this terminal. The duties of the men at the inspection pits are of interest as these men are all specialists. There are 11 inspectors on each trick divided as follows, six outside and three underneath machinery inspectors, and two air brake inspectors. The duties of the outside machine inspectors are to examine all external machinery and the tender; underneath inspectors inspect all machinery of a locomotive accessible only by the use of a pit, gage, test and adjust the water scoops and assist

Table II—Distribution of working force at East Altoona engine terminal by tricks and crafts

	1	2	3	Total
Office				
Lead clerk	1	0	0	1
Clerks	16	5	8	29
Dispatches	2	2	2	6
Gang foremen, special duty	4	1	1	6
Machinist	1	0	0	1
Machinist helper	1	0	0	1
Machinist apprentice	5	0	0	5
Piece work inspector	1	0	0	1
Messengers	2	0	0	2
Extra hostlers	20	0	0	20
Enginehouse				
Foremen	1	0	1	2
Assistant foremen	1	0	1	2
Gang foremen	10	5	2	17
Machinists	69	48	25	142
Machinist helpers	54	49	25	126
Machinist helper apprentice	4	0	0	4
Machinist apprentice	6	0	0	6
Boilermakers	15	8	3	25
Boilermaker helpers	22	13	3	38
Boilermaker helper appren	1	0	0	1
Boiler washers	2	1	1	4
Boiler inspectors	2	1	1	4
Locomotive inspectors	1	2	1	4
Pipe fitters	6	2	2	10
Pipe fitter helpers	3	2	2	7
Tender repairmen	9	3	3	15
Tender repairmen helpers	5	4	2	11
Carpenters	2	0	0	2
Painters	1	0	0	1
Oilers	2	0	0	2
Locomotive preparers	4	4	4	12
Laborers	8	1	0	9
Clerks	2	0	0	2
Yard gangs				
Assistant foremen	1	0	1	2
Gang foremen	5	5	5	15
Gang leader, ashmen	1	1	1	3
Gang leaders, laborers	3	1	0	4
Machinists	54	29	24	107
Machinist helpers	26	23	23	72
Machinist helper apprentices	2	0	0	2
Machinist apprentices	4	0	0	4
Boilermakers	2	0	3	5
Boilermaker helpers	2	0	0	2
Locomotive inspectors	12	12	12	36
Electricians	5	2	3	10
Electrician helper apprentices	1	0	0	1
Electrician helpers	2	0	0	2
Plumbers	1	0	0	1
Pipe fitters	5	0	0	5
Pipe fitter apprentice helpers	4	0	0	4
Crane operators	2	1	1	4
Turntable operators	2	2	2	6
Stationary engineers	1	1	1	3
Stationary firemen	4	4	4	12
Blacksmiths	3	1	1	5
Blacksmith helpers	5	1	1	7
Coppersmiths	1	1	1	3
Coppersmith helpers	1	0	0	1
Sheet metal workers	1	0	0	1
Toolroom attendants	1	1	1	3
Laborers	77	27	27	131
Hostlers	24	23	21	68
Locomotive preparers	12	11	11	34
Switch attendants	2	2	2	6
Oilers	7	7	7	21
Clerks	2	2	1	5
Truck drivers	2	0	0	2
Janitors	4	2	1	7
Ashmen	2	1	0	3

the air inspector in the cab in testing the brake equipment. The duties of the air inspectors are to test all air equipment, the stoker, the feedwater heater and injectors. They make all light repairs, such as changing feed valves and air compressor governors and adjust the bell ringers and the driving and tender brake cylinder piston travel. One air inspector works in the cab and operates the brakes, stokers and feedwater heater, while the other on the ground inspects the brake rigging, checks the brake piston travel and makes necessary light repairs. One machinist is assigned at the inspection pit to oil and adjust the wedges. Another machinist, who is known as the cab inspector, looks after the certificates, gage cocks, etc. He

The west end of the air brake instruction room, showing the triple valve test rack at the left

also directs the movement of the power to the storage yards and acts as an extra supervisor when needed. The headlights are not examined at the inspection pit as this work is done on the storage sidings. In addition to the workmen already mentioned, there are located at the inspection pit a box packer for grease cellars, a man who sponges the engine trucks, trailer and tender journals, two grease cup fillers, one tool boy who removes surplus supplies and tools from the locomotives, one lamp filler who cleans and fills all lamps and one front end boiler inspector.

It will be noticed in Table II that 20 extra hostlers are listed as part of the office force during the first trick. The names of these hostlers are carried on a crew board. They are called for duty in rotation. The purpose of these extra men is to fill in vacancies caused by absence. They are also called when the regular forces are not able to handle an emergency situation caused by an exceptionally large number of locomotives arriving at the terminal. The extra hostlers average six days a week.

Method of handling locomotives through East Altoona terminal

The locomotives enter the enginehouse layout at AL tower, located at the west end of the terminal. The arrival time of a locomotive is taken at this point. This tower is operated by a switch attendant, under the supervision of the inspection pit foreman. Engines from the west are directed to the two inspection pits south of the coal trestle and those from the east to the pits north of the coal trestle. The locomotives before they are moved onto the inspection pit are washed by two men. Located at the inspection pit are two hostlers, one for each of the two tracks, who move the locomotives onto the pits and take them to the ash pits.

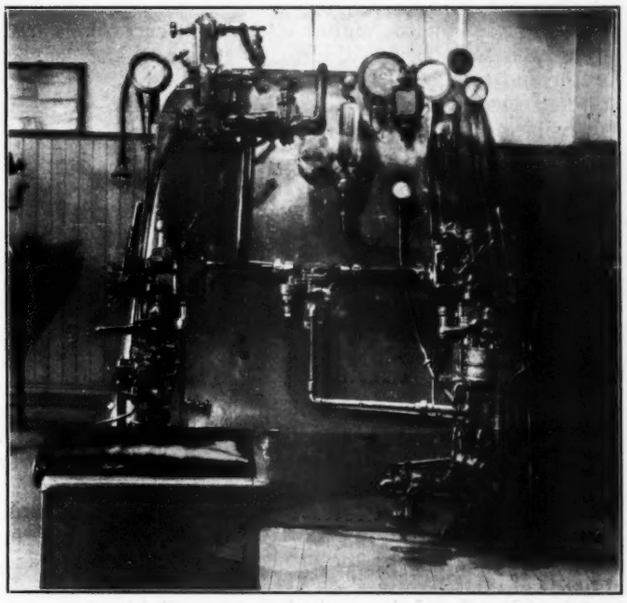
The inspectors make out their work reports after the locomotives are inspected and these are attached to the enginemen's work reports. The reports are then checked and notations made on them of the repairs made by the inspectors. The reports are then sent through a pneumatic tube to the enginehouse foreman's office where the necessary work charts are made out and the whole turned over to the work distributor located at this office. The average time for inspection is 12 min. for each locomotive.

Before a locomotive is moved from the inspection pit, the cab inspector marks the destination of the engine on the back board on the left side in the cab, using the following code:

O.K.S.—Fire up and place on siding
O.K.H.—Fire up and place in house
F.O.S.—Fire cut and place on siding
F.O.H.—Fire cut and place in house

In connection with this code a list of 40 numerals is used, each to designate one of 40 important jobs commonly encountered in the engine terminal. For example, 0 indicates "Firebox leaking"; 1 indicates "Flues leaking"; 9 indicates "Dry pipe work" and 39 indicates "Change water in boiler."

If, for instance, the cab is "F.O.S. 1," this means that the fire should be dropped and the locomotive placed on the siding on account of leaking flues. The foreman at



A replica of a locomotive boiler head fully equipped with different types of air brakes, together with cut sections of accessories commonly found on a boiler head

the inspection pits notifies the work distributor by telephone as to whether the locomotive will be placed in the house or on the siding and the nature of the repairs. The inspection pit hostler then places the locomotive on the ash pit where it is taken in charge by an ash pit hostler. Before returning to the inspection pit for another locomotive, the hostler makes a notation in a record book of the condition of the fire, the amount of water in the boiler and the steam pressure. The purpose of this record is to protect the inspection pit hostler in case of damage to the locomotive caused by low water.

The ash pit hostler cleans or drops the fire, according to the code notation in the cab, and moves the locomotive

to the coal trestle, where it is coaled and sanded, after which the tank is filled with water by the hostler. He then moves the engine to the 110-ft. turntable located at the extreme eastern end of the terminal, where the locomotive is turned and placed either on the west or east bound siding, as the case may be. The average time of the locomotive from AL tower to its arrival on the storage siding is 1 hr. 55 min.

The work done on the storage sidings

During the first trick, the organization of the west bound and east bound sidings consist of two machinists and one hostler gang and one machinist and one hostler gang, respectively. The second and third trick organization is the same, except that the west bound siding has only one machinist gang. Each siding is provided with a pit for underneath work. The class of work done on the locomotives in the storage siding is as follows: Setting valves, closing and renewing rod brasses, renewing main rod bushings, driving springs, brake rigging, piston packing and other miscellaneous work. In addition, the throttle, stoker, feedwater heater, boiler checks, grates, arch tubes, arches, or any other work requiring the fire to be removed and the locomotive blown down. The locomotives are repaired by two boilermakers and helpers and one machinist stationed at two tracks equipped with steam and water for making repairs and firing up. The tracks are located parallel to the eastern end of the coal trestle. The duties of the hostler leader on the storage sidings are to see that the locomotives are sorted and finally placed on the siding in rotation according to the time each will be available to take care of the coal and water and to check any terminal delays. In other words, after a locomotive has been repaired, the hostler is responsible for its leaving the terminal on time.

Method of handling repairs in the enginehouse

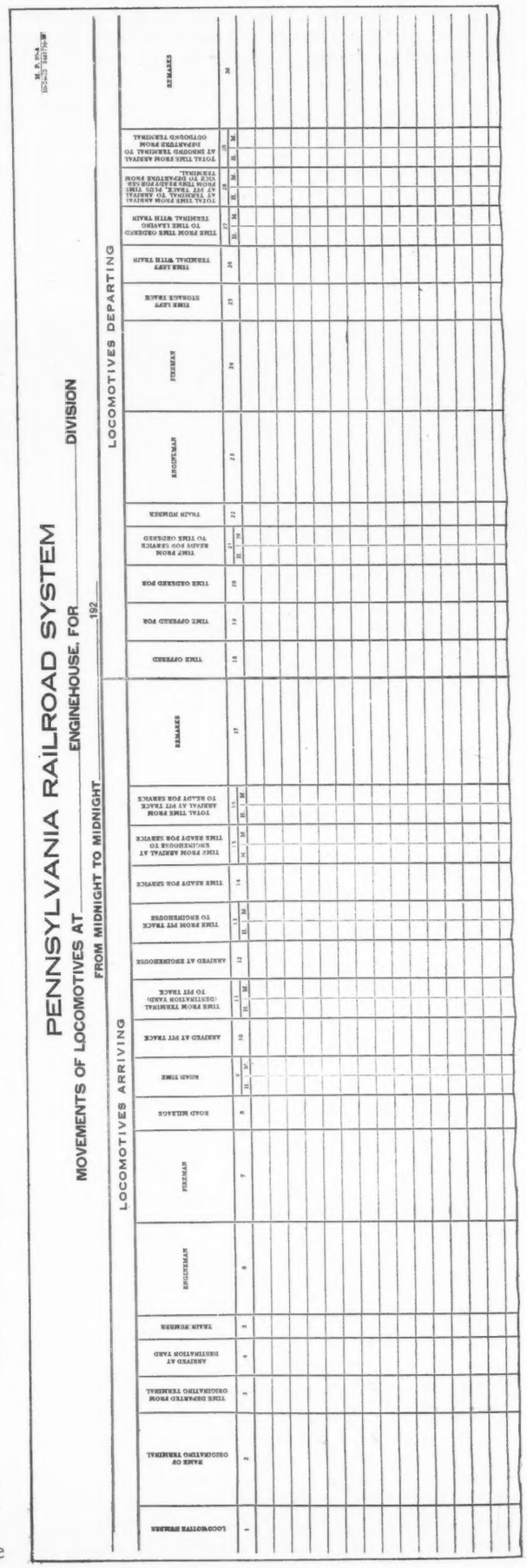
When a locomotive, due for a boiler wash arrives at the inspection pit it is placed in the house by the ash pit hostler. Other work which necessitates a locomotive going into the house includes wheel and driving box repairs, renewal of crown and staybolts, broken frames, removal of superheater units and the renewal of a center deck casting or a cylinder.

The machinery, boiler and tender of a locomotive in for boiler washing is examined by the various inspectors, who are governed in their work by the Pennsylvania Locomotive Maintenance Instructions. The inspectors' reports are sent to the work report clerk in the main office. It should be noted that the valves and cylinder packing are not examined at this time or at any set period, but only when reported on the inspectors' or enginmen's work reports.

The 50 stalls of the enginehouse are divided into three sections, 42 of which are for heavy repairs, four for tank work and four for drop pits. The 42 stalls are divided among four machinist gang foremen on the first trick and two each on the second and third tricks. After all repairs have been made, the locomotives are fired, tested and then passed over to the inspection pit where a thorough inspection is made before they are placed on the storage tracks. Any work found by this inspection is completed on the storage tracks. The ash pit hostlers move the locomotives out of the house.

Method of dispatching power

The work distributor keeps the engine dispatchers posted as to the condition of the power and when it will be available for service. The dispatchers usually know about two hours in advance when the locomotives can be ordered. Specific locomotives are not ordered by the

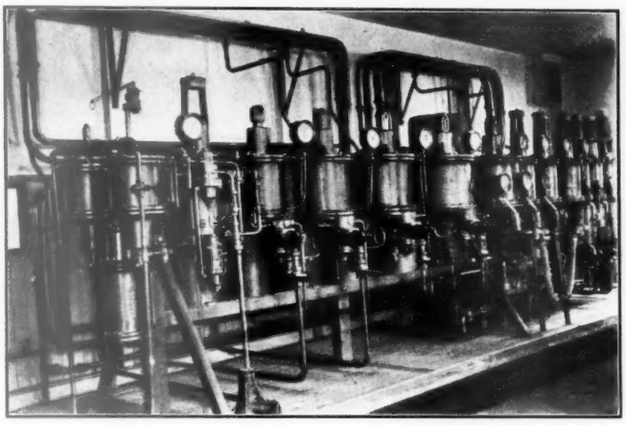

PENNSYLVANIA RAILROAD SYSTEM
DIVISION
MOVEMENTS OF LOCOMOTIVES AT ENGINEHOUSE, FOR 192
FROM MIDNIGHT TO MIDNIGHT
LOCOMOTIVES ARRIVING
LOCOMOTIVES DEPARTING
LOCOMOTIVE NUMBER
RANK OF ORIGINATING TERMINAL
TIME DEPARTED FROM ORIGINATING TERMINAL
ARRIVED AT DESTINATION YARD
TRAIN NUMBER
ENGINEMAN
FIREMAN
ROAD MILEAGE
MAIN TIMES
ARRIVED AT PIT TRACK
TIME FROM TERMINAL (DESTINATION YARD) TO PIT TRACK
ARRIVED AT ENGINEHOUSE
TIME FROM PIT TRACK TO ENGINEHOUSE
TIME READY FOR SERVICE
TIME FROM ARRIVAL AT ENGINEHOUSE TO TIME READY FOR SERVICE
TOTAL TIME FROM ARRIVAL AT PIT TRACK TO READY FOR SERVICE
REMARKS
TIME OFFERED
TIME OFFERED FOR
TIME ORDERED FOR
TIME FROM ARRIVAL TO TIME ORDERED
TRAIN NUMBER
ENGINEMAN
FIREMAN
TIME LEFT STORAGE TRACK
TIME LEFT TERMINAL WITH TRAIN
TIME FROM TIME ORDERED TO TIME LEAVING TERMINAL WITH TRAIN
TOTAL TIME FROM ARRIVAL AT TERMINAL TO ARRIVAL AT PIT TRACK, PLUS TIME FROM TIME READY FOR SERVICE TO DEPARTURE FROM TERMINAL
TOTAL TIME FROM ARRIVAL AT INBOUND TERMINAL TO DEPARTURE FROM OUTBOUND TERMINAL
REMARKS

This form shows the movements of the locomotives through the terminal for a 24-hr. period

transportation department, but instead this department places an order to haul a certain tonnage train over a designated division. The engine dispatcher selects the locomotive or locomotives suitable to haul the train. In leaving the terminal, the engine crews must pass the storage track foreman's office at the time specified in the call.

A clerk in the engine dispatcher's office fills out what is known as the M.P. 99-A sheet which is a complete record from midnight to midnight of the movements of all locomotives by divisions at the East Altoona enginehouse. This form, which is shown in one of the illustration, is standard on the Pennsylvania System. It is divided into two parts, one a complete record of the locomotives arriving and the other a complete record of the locomotives departing. Columns 1 and 2 are self-explanatory. Column 3 shows the time the locomotive departed from the originating terminal, and column 4, the time of arrival at the destination yard. These columns are filled out from the engineman's time slip. Columns 5, 6 and 7 need no explanation. Column 8 is taken from the engineman's time slip and column 9, or the road time, is the difference between columns 3 and 4. Column 10 shows the arrival at the pit track, which time is taken by the switch attendant at AL tower, where the locomotives enter the jurisdiction of the mechanical department. Column 11, or the time from the destination yard to the pit track, is the difference between columns 4 and 10. Column 12 shows the time at which the locomotive became available for maintenance work, either in the enginehouse or on the storage tracks. It is obtained by the lower turntable operator. Column 13, or the time from the pit track to the enginehouse, is the difference between columns 10 and 12. Column 14, or the time ready for service, indicates the time after which the locomotive may be ordered, and is furnished to the dispatcher by the work distributor. Column 15 indicates the time from the arrival at the enginehouse to the time ready for service and is the difference between columns 12 and 14. Column 16 shows the total time from the arrival to the pit track to the time ready for service, which is the difference between columns 10 and 14, or the total time required by the motive power department to pass the engine through the terminal and have it ready for service. In column 17, remarks may be noted to show any unusual conditions which detain the progress of a locomotive as it passes through the terminal.

Column 18, or the time offered, is the time that the work distributor offers the locomotive for service. The time ordered for service in column 20 is the time designated by the engine dispatcher at which the locomotive must leave the jurisdiction of the engine terminal. Column 21, or the time from ready for service to the time ordered, is the difference between columns 14 and 20. Columns 22, 23 and 24 need no additional explanation. Column 25, or the time the locomotive leaves the storage track, is obtained by the storage track foreman as the locomotive passes his office. If the time in column 25 is later than the time ordered, column 20, an engine terminal delay results which must be accounted for to the general foreman. Column 26 shows the time the engine leaves the terminal with its train. This time is obtained from a tower man in the yard. Column 27 is the difference between columns 20 and 26. The total time from the arrival at the terminal to the arrival at the pit track plus the time from the time ready for service to departure from the terminal is shown in column 28 which is obtained by adding the time shown in column 11 plus the difference between column 14 and column 26. In other words, this column shows the time that the locomotive has been under the jurisdiction of the transportation department from the time of its arrival to its departure. Column 29, or the total time from the arrival at the inbound terminal to the departure from the outbound terminal is the addition of the time shown in columns 11, 16, 21 and 27. In column 30 any remarks may be inserted which will indicate why a locomotive was late in departing.



This test rack, which is located in the air brake instruction, has a brake pipe volume equal to an 80-car train

PENNSYLVANIA RAILROAD SYSTEM

MOVEMENT OF ROAD FREIGHT LOCOMOTIVES

For ..... Division At ..... Enginehouse

Month of ..... 192....

DATE	NUMBER OF LOCOS. DISPATCHED	TOTAL ROAD MILEAGE	TOTAL ROAD TIME	TIME FROM TERMINAL TO PIT TRACK	TIME FROM PIT TRACK TO ENGINEHOUSE	TIME FROM ARRIVAL AT ENGINEHOUSE TO TIME READY FOR SERVICE	TOTAL TIME FROM ARRIVAL AT PIT TRACK TO READY FOR SERVICE	TIME FROM READY FOR SERVICE TO TIME ORDERED	TIME FROM TIME ORDERED TO TIME LEAVING TERMINAL WITH TRAIN	TOTAL TIME FROM ARRIVAL AT TERMINAL TO ARRIVAL AT PIT TRACK PLUS TIME FROM READY FOR SERVICE TO DEPARTURE FROM TERMINAL	TOTAL TIME FROM ARRIVAL AT INBOUND TERMINAL TO DEPARTURE FROM OUTBOUND TERMINAL
	X	Col. 8 A	Col. 9 B	Col. 11 C	Col. 13 D	Col. 15 E	Col. 16 F	Col. 21 G	Col. 27 H	Col. 28 I	Col. 29 J
			Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.	Hrs. Mins.
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											
21											
22											
23											
24											
25											
26											
27											
28											
29											
30											
31											
TOTAL											
AVERAGE											

The average of 11 columns on the M. P. 99-A sheet are transferred every day to this form and at the end of each month the columns are again averaged, which shows the monthly performance at the engine terminal

At the end of each 24-hr. period, columns 8, 9, 11, 13, 15, 16, 21, 27, 28 and 29 on the M.P. 99-A sheet are added up and divided by the total number of locomotives dispatched. These averages are then transferred to the M.P. 99-B sheet shown in one of the accompanying illustrations. This sheet contains space for a 31-day month and at the end of the month, the figures transferred are again added up and divided by the number of locomotives dispatched to obtain monthly averages for each column.

Rack for storing boiler front ends

By Charles W. Geiger

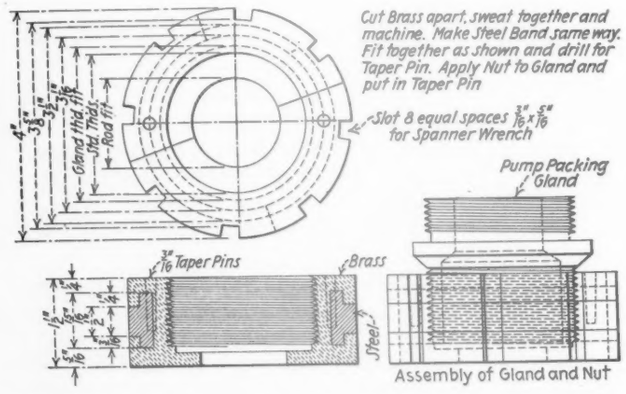
THE illustration shows a convenient rack for storing the front ends of locomotive boilers. The frame is of timber construction and the partition uprights are made from old boiler tubes. Sufficient space is provided between the boiler tubes for one front end. This type of rack is used in one of the general repair shops of a southwestern railroad and is located just outside of the erecting shop, as shown in the illustration. The use of this rack facilitates the storing of front ends while the locomotive is going through the shop. They can be easily placed or removed without disturbing any of the other front ends as is usually the case when piled against a wall.

Rack for storing locomotive front ends, made of old boiler tubes

Emergency packing nut for feedwater heater pumps

By W. W. Dooley

THE packing nut, a cross section of which is shown in the sketch, was made for the purpose of reducing the time usually required to renew a burst packing or stuffing box nut, on the piston rod of the water pump of an Elesco feedwater heater or an air compressor. The nut is made in halves which are held together when applied by a steel band, also made in halves which are held in place by two 3/16-in. taper pins. The emergency nut is applied by fitting the halves together on the gland, sliding the halves of the steel band around approximately 90 degrees in the slot and drilling the holes for the taper pins. After the nut is applied to the gland the taper pins are inserted in the holes.


Cut Brass apart, sweat together and machine. Make Steel Band same way. Fit together as shown and drill for Taper Pin. Apply Nut to Gland and put in Taper Pin
Slot 8 equal spaces 3/16 x 5/16 for Spanner Wrench
Pump Packing Gland
3/16 Taper Pins
Brass
Steel
Assembly of Gland and Nut

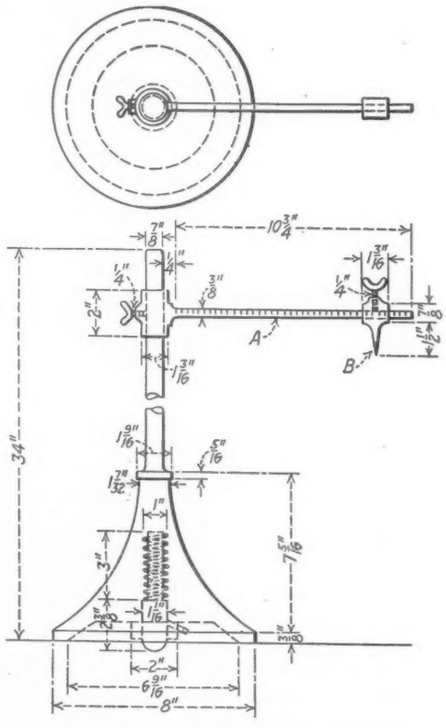
This split stuffing box nut can be applied to the piston rod of a feedwater heater pump or an air compressor in three minutes

This nut was originally devised when we recently had a locomotive ordered for service and a mechanic was sent to pack the feedwater heater pump. He found the packing nut burst and the renewal of this nut caused a four-hour delay. We decided it was cheaper to keep an emergency nut handy such as the one described, for just such occasions. It can be applied on a feed water pump in three minutes.

Gage for locating eccentric cranks

By J. Robert Phelps,
Apprentice instructor, A. T. & S. F., San Bernardino, Cal.

ACCURACY is essential when locating eccentric cranks on the main pins. The gage shown in the accompanying illustration has been designed to secure this accuracy. The hollow base of the gage contains a center which is moved in and out by a spring. This center fits into the center of the driving axle. On top of the base is attached a rod 7/8 in. in diameter and 27 in. long, over which slides, at right angles, a graduated rod *A* 3/8 in. in diameter. A movable pointer *B* slides along rod *A*. The point *B* may be set at any distance from the center of the rod without the use of a scale. The rod *A* can be fastened at any position on the perpendicular rod by means of a winged nut.



A graduated eccentric crank gage

Handling Material in Railroad Shops

Developments in equipment have facilitated work of routing material—Efficient operation depends on prompt deliveries

THE methods used in laying out railroad shops have gone through several distinct changes during the past 30 years. It was formerly the practice to build a shop according to conventional ideas and fit in the machine tools and shop equipment wherever they would go. Then came the period of building the shop around the equipment, or to suit the desired layout. We have now entered a third stage in the progress of shop layout methods in which the engineer considers the shop layout largely from the standpoint of handling material from one department to another, as well as routing material through a single department.

There is, however, a fault to be found with the method of laying out a railroad shop with the principal idea of facilitating the handling of material. Quite often an engine terminal with a small machine shop will gradually develop into a large back shop. It is seldom possible to expand in a logical direction and as the shop becomes larger, excrescences will develop at various points in the shop layout that seriously affect the efficiency of any system of handling material.

This fault, however, has been a big factor in the development of material handling equipment. Practically all railroad shops have some abnormal or unforeseen development in their layouts that have created difficulties in handling material and, as a result, the managements of the railroad shops have been required to use considerable ingenuity in overcoming these difficulties. In this the manufacturers of material handling equipment have been of invaluable assistance in developing a variety of cranes, conveyors, trucks and other types of handling equipment from among which the mechanical or stores department officer can select that which is best suited to meet his particular problem.

Material handling equipment used in railroad shops may be classified under three general heads, namely, trucks, cranes and conveyors. These classifications may in turn be divided into different groups, according to type of equipment. Trucks include such material handling equipment as the simple forms of hand trucks, carts and wheelbarrows, the various forms of power driven trucks as distinguished from tractors, and tractors and trailers.

Variety of systems used for handling material with trucks, tractors and trailers

The efficient utilization of industrial trucks, tractors and trailers depends to a large extent on the degree of co-operation between the stores and mechanical departments. It has been only during the past few years that many railroads have come to a realization that whole-hearted co-operation between these two departments is essential in order to reduce the cost of locomotive and car maintenance. But during that time rapid progress has been made towards getting the stores and mechanical departments working more closely together.

In many shops all handling of material from the store room or yard to the material station, machine, or car or locomotive, is under the supervision of the stores department. It seems to be the practice, however, for many mechanical departments to supervise the delivery of all material. Requisitions for material are made out by a shop foreman and collected by the delivery man, who delivers them to the stores department delivery attendant for

Fig. 1—Locomotive cranes can be used for many kinds of jobs around a railroad shop. Fig. 2—Efficient ash handling equipment facilitates engine terminal operation. Fig. 3—A Whiting 150-ton overhead-traveling crane in a locomotive erecting shop. Fig. 4—Adequate coaling facilities reduce the time of turning locomotives. Fig. 5—Handling ashes from the power plant to the car. Fig. 6—Overhead-traveling crane equipped with a bucket for handling ashes from an ash-pit. Fig. 7—Overhead-traveling cranes can be used to advantage for handling castings in the storage yard

filling. The material is loaded on trailers where it is checked against the requisition and the requisition form is receipted by the man who has charge of delivering the material.

A variety of delivery systems used in various railroad shops throughout the country have been described in past issues of the *Railway Mechanical Engineer*. A typical example of a modern delivery system is that used in the locomotive and car shops of the Lehigh Valley at Sayre, Pa. These shops have organized a system of material delivery that has produced many economies. The equipment used consists of four Elwell-Parker trucks and one Tow-Motor, which are operated by crews of two men each. A variety of trailers for handling different kinds of material, some of which are illustrated, are also provided. These trucks and trailers are operated on a schedule which is rigidly adhered to, emergency requisitions being handled by a special truck. Material stations are located at strategic points throughout the car and locomotive shops at which the truck train stops for the delivery of material and the collection of requisitions or orders for material. The schedule of deliveries and the location of material stations in the locomotive shop is shown in a drawing. A hook is provided at each station on which all orders for material are hung, to be collected by the delivery man.

Perhaps the most modern system both in the kind of equipment and method of operation is to be found in the Scranton locomotive shops of the Delaware, Lackawanna & Western. When the shop was constructed a subway system was built under the plant through which narrow gage tracks were constructed for the operation of cars by electric locomotives. Several years ago the electric locomotive was abandoned as motive power in favor of electric trucks which are now operated through the subways. The rail cars are used primarily for scrap and are moved by electric truck as shown in one of the illustrations.

Material is brought from the stores department by subway to an elevator located at the center of the shop. From this central point all material can be readily routed to any department. Another feature of the operation of this shop is that sub-departments, such as that handling driving boxes, each has a truck assigned to it which

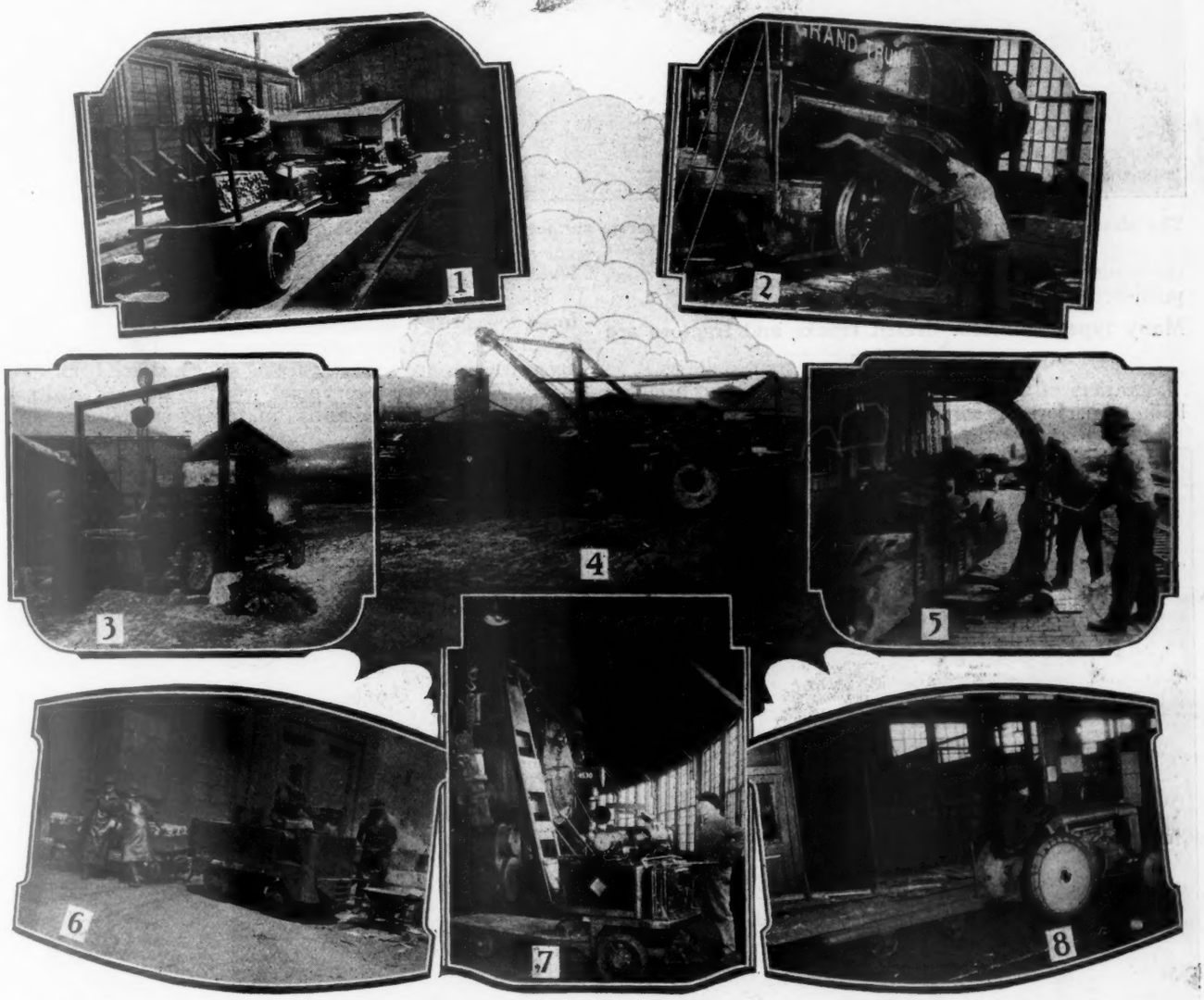


Fig. 1—Platform truck and trailers delivering material from the store room. Fig. 2—Crane truck equipped with auxiliary arm for applying main air reservoirs to locomotives. Fig. 3.—Loading car couplers on a truck with a chain hoist. Fig. 4—Rix-Fordson tractor handling material in a storage yard. Fig. 5—Crane trucks facilitate the work of handling heavy castings. Fig. 6—Truck and trailers running on a schedule speeds up production in the car shop. Fig. 7—Crane trucks equipped with long booms are of material assistance in erecting shop work. Fig. 8—Fordson tractor delivering material by trailer.

operates under the supervision of the foreman. This truck is available for transporting boxes to and from the foundry as well as material from the storeroom. For a description of the scheduling system used in these shops the reader is referred to an article by E. A. Koschinske, published elsewhere in this issue.

The ideal type of driveway for trucking material—A concrete surface has a tractive resistance of from 28 lb. to 40 lb. per ton

Many types of motor driven trucks and tractors are available

A variety of gasoline and electric driven trucks are now built to perform general and special service in railroad shops. A number of uses for different types of trucks and tractors are illustrated. The platform truck is built in various sizes with a maximum capacity of about 4,000 lb. The platform is usually from 20 in. to 24 in. above the ground and is designed primarily for service where the hauling is restricted to narrow aisles and runways. The low platform type has a platform about 11 in. to 17 in. above the ground and is best adapted for carrying heavy pieces, such as castings weighing from 150 lb. to 200 lb. The greater the weight of the pieces to be loaded the lower the platform should be to eliminate high lifting.

The elevating platform type is similar to the low platform, except that it has a movable platform which can be raised or lowered by a separate electric motor. The elevating platforms are built in various sizes and are from 10¼ in. to 17 in. above the ground when in lowered position. They have a lift of from 3½ in. to 4½ in. This type of truck has an advantage over other types of power trucks in being able to work more continuously. Standing time and extra handling are eliminated if the load is of such a nature that it can be carried on wooden or metal skid platforms. The platform end of the truck runs under the skid platform and elevates it and the truck then moves to

The old versus the new—An electric platform truck hauling material from the storage yard of a locomotive shop

the desired location. The elevating platform truck is recommended where the volume of material to be moved and the length of haul precludes the use of the hand lift truck.

The tiering truck has many applications over a wide range and is similar in many respects to the elevating platform type. The lifting and driving devices are separated, but both can be operated at the same time if desired. This factor greatly facilitates the ease and speed at which this truck may be operated. It has the additional feature of tiering the load from 1 in. to 6 ft. or more, and can be used for loading boxes, barrels or bales onto automobile trucks or into freight cars. It can also be used to advantage for tiering in the store room and for placing heavy dies or stock in machines. It is recommended for use with skid platforms for hauling material and also for piling the loaded or empty skid platforms for storage. A useful accessory to this type is a platform with rollers. This platform is permanently fastened to the lifting arm and permits heavy loads to be easily pushed on or off when it is in an elevated or lowered position.

The crane type, applications of which are shown in some of the illustrations, is especially adapted to handling heavy weights in localities where the truck must move but short distances. Trucks of this type are equipped with either an electrically or hand operated crane of from

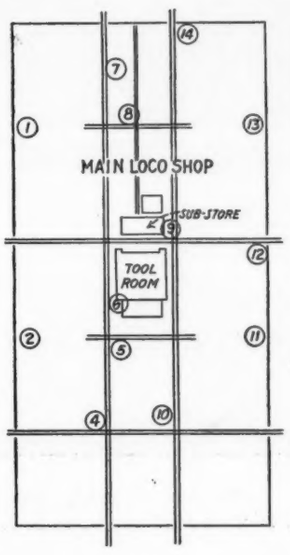
STORE HOUSE

TIME TABLE

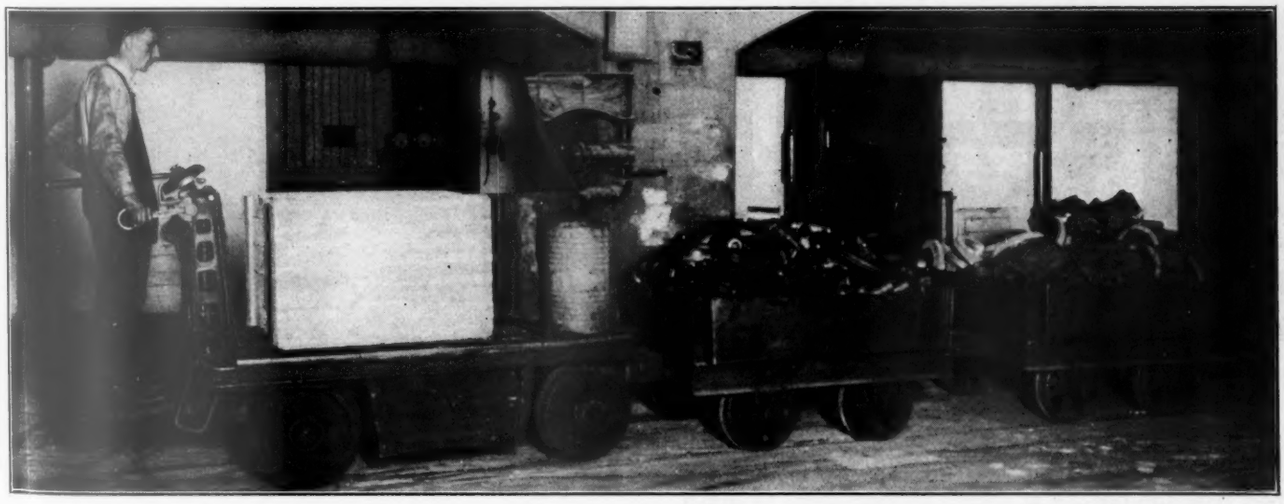
NO.	STATION LOCATION	TIME A.M.	A.M.	A.M.	A.M.	A.M.	P.M.	P.M.	P.M.	P.M.
	STOREHOUSE — Lv.	7:30	8:15	9:30	11:00	11:30	1:00	1:30	2:00	3:00
1	WEST BAY — PIT #47	7:35	—	9:35	—	11:35	1:05	—	2:05	3:05
2	WEST BAY — PIT #33	7:35	—	9:35	—	11:35	1:05	—	2:05	3:05
3	TANK SHOP	—	8:25	—	11:10	—	—	1:40	—	—
4	CAB SHOP - NOR. END	7:40	—	9:40	—	11:40	1:10	—	2:10	3:10
5	PISTON AND REPAIR DEPARTMENTS	7:40	—	9:40	—	11:40	1:10	—	2:10	3:10
6	ELECT. TOOL AND PAINT DEPARTMENTS	7:40	—	9:40	—	11:40	1:10	—	2:10	3:10
7	WEST MACH. BAY — NORTH END	7:45	—	9:45	—	11:45	1:15	—	2:15	3:15
8	AIR, ROD AND MOTION DEPARTMENT	7:45	—	9:45	—	11:45	1:15	—	2:15	3:15
9	SUB STORE	7:50	—	9:50	—	11:50	1:20	—	2:20	3:20
10	BOILER AND PIPE DEPARTMENTS	7:50	—	9:50	—	11:50	1:20	—	2:20	3:20
11	EAST BAY — PIT #20	7:50	—	9:50	—	11:50	1:20	—	2:20	3:20
12	EAST BAY — PIT #15	7:55	—	9:55	—	11:55	1:25	—	2:25	3:25
13	EAST BAY — PIT #7	7:55	—	9:55	—	11:55	1:25	—	2:25	3:25
14	EAST MACH. BAY NORTH END	7:55	—	9:55	—	11:55	1:25	—	2:25	3:25

NOTE:- ORDERS MUST BE ON STATION HOOKS 15 MINUTES BEFORE TIME SCHEDULED FOR TRUCK TO CALL.
MATERIAL DELIVERED MUST BE REMOVED FROM STATION.
KEEP AISLES AND PASSAGEWAYS CLEAR.
DO NOT HOLD UP TRACTOR.

LOCATION OF STATIONS



Storehouse and locomotive shop delivery system used at the Lehigh Valley shops, Sayre, Pa.



View in the subway of the Delaware, Lackawanna & Western locomotive shops, Scranton, Pa.—Handling scrap from the back shop to the foundry

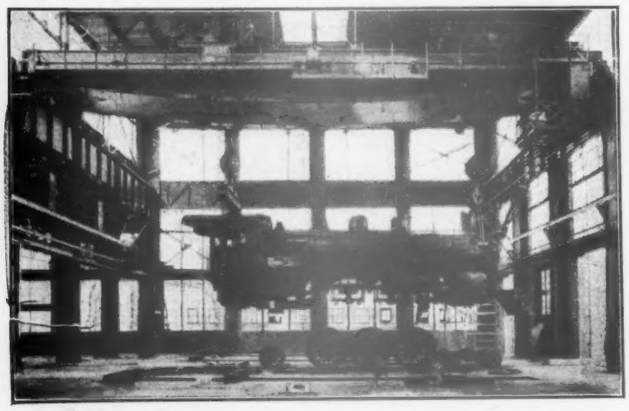
1,000 lb. to 3,000 lb. capacity, mounted permanently or temporarily on the load carrying or low platform models. The compensating boom is equipped with a swivel base so that it will swing 90 deg. or more each way. The load may be carried on the hook or lifted by the crane to or from the truck platform. A modification of this type, equipped with a magnet attached to the hook on the

Overhead traveling cranes are generally used in car shops using the station-to-station system of repairs

crane, is useful for lifting castings, scrap iron or steel. Other modifications of this type are available, having a larger boom of stronger construction for heavier loads.

Gasoline engine trucks

Trucks powered with gasoline engines have a somewhat higher speed than the storage battery type and can be used advantageously in many places. Trucks of this

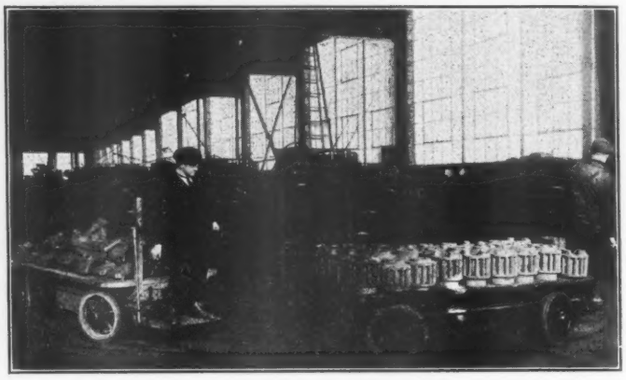


Overhead traveling crane service is a necessary part of the equipment of an erecting shop

type are designed with an average capacity of 2,500 lb. in the three-wheel type and 3,000 lb. capacity in the four-wheel type and operate at speeds varying from ½ m.p.h. to 12 m.p.h. They are especially adapted for interdepartment service where long hauls are involved and for out-of-door service. Gasoline engine trucks might be considered best applicable for hauls that would extend somewhat further than the usual hauling distance of the storage battery type.

The installation of gasoline tractor and trailer methods for the handling of material in and about railroad shops has been of considerable assistance in solving the material handling problem of a number of important railroads. This type of motorized equipment will move material in large or small units, quickly and efficiently to any desired point. It eliminates the services of laborers with individual hand trucks and reduces the amount of material transportation required in modern railroad shops.

Typical examples of the successful use of tractor-trailer methods for efficiently handling material have been



Crescent electric platform trucks transportating small parts in a machine shop

described in past issues of the *Railway Mechanical Engineer*. At the Albuquerque shops,* of the Atchison, Topeka & Santa Fe, a trucking service has been installed using Ford tractors and trailers. This service is on a schedule run to all parts of the shop over a regular route. Material is picked up at any station and is carried to other

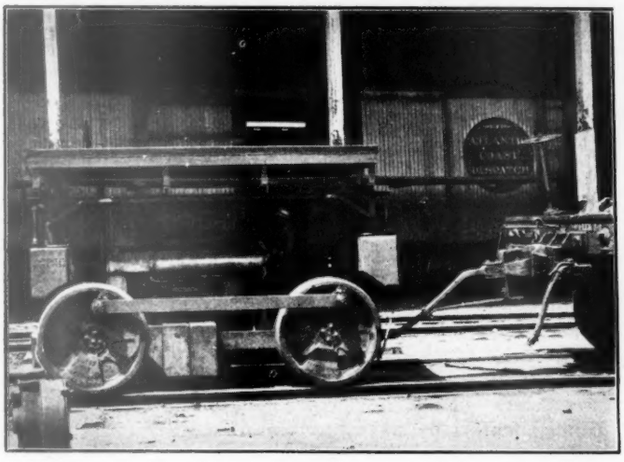
Low platform electric truck hauling a trailer loaded with couplers

stations at any point desired. Each column in the shop building has a station number and it is only necessary for the foreman to indicate on the order the station to which the material is to be delivered. One complete trip is made

*See the June, 1924, issue of the *Railway Mechanical Engineer*, page 233.

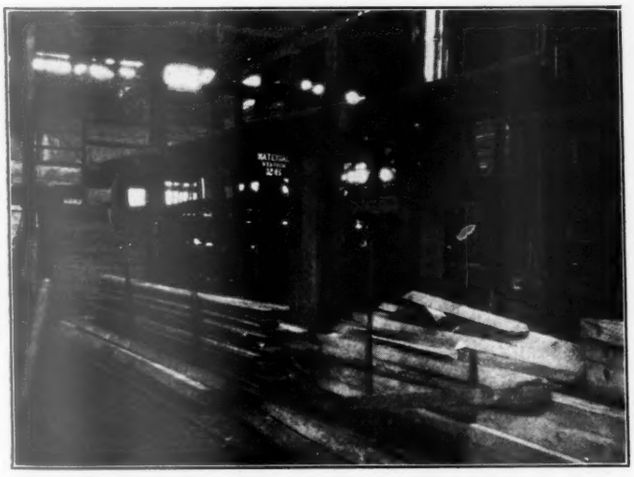
every hour to all parts of the shop. Fordson tractors and trailers are also used at the Finley shops of the Southern, Birmingham, Ala., for the handling of lumber and other material in and about the car repair yards. The Erie uses three power-driven trucks, two tractors and ten trailers in its locomotive shops at Kent, Ohio. This equipment supplies 400 workmen with material.

The interesting development of the tractor is the seem-



Fordson tractor equipped with flanged wheels for hauling scrap cars from the car repair yard to the power plant at the Rocky Mount, N. C., shops of the Atlantic Coast Line

ingly innumerable applications and uses to which it can be put. The fact that the Fordson tractor includes quite a number of standard Ford automobile parts, which are easily procurable, is perhaps one reason for its adaptability for alteration to suit a wide variety of service requirements. One of the illustrations shows a Fordson tractor which has been altered for rail service and is used to eliminate the services of a switching locomotive for handling scrap material from the car repair tracks to the power



Material station No. 26 in the car shop of the Lehigh Valley, Sayre, Pa.

plant at the Rocky Mount, N. C., shops of the Atlantic Coast Line. This tractor, coupled to two or three flat cars, is moved about the yard at the convenience of the shop forces and all wood scrap material is loaded on the flat cars and taken to the power plant where it is burned.

Many types of trailers have been developed throughout the country for handling different kinds of material. In all probability the car department is the worst offender in not adopting standard types of trailers. It would seem that standard trailer types could be developed for car department use more easily than for the locomotive department, owing to the fact that there is a less variety in the shapes of material to be handled. As a rule, trailer trucks are built in the shop and are not purchased from the manufacturers of material handling equipment. For this reason it would seem logical that the car department make a study of the best type of trailer truck to be used for certain services and then adopt it as standard.

Cranes, conveyors and overhead carrying systems

Cranes are grouped into several classes, such as overhead, travelling, gantry, jib, locomotive and roof cranes. The advantages of cranes as labor saving devices are well recognized and the benefits derived from their use have led to their wide application in railroad shop work.

The average locomotive repair shop comprises from eight to 10 major departments. The number of men em-

Two-wheel trailer truck used at the car shops of the Lehigh Valley, Sayre, Pa.

ployed and the amount of equipment installed depends largely on the number of locomotive repair pits in the main erecting shop. Certain class repairs to locomotives involve removing of practically all accessories and machinery parts and transporting them to the various departments. Practically all of this work is performed by overhead travelling cranes, the fundamental operations of which are well understood. Another use of overhead travelling cranes, and quite often gantry cranes, is in car shops where the station-to-station system of repairs is used.

There are, however, many shops and engine terminals in which the operation could be considerably improved by the installation of more adequate crane facilities. There are times in every enginehouse when speed is a vital necessity. The availability of overhead crane facilities as well as jib cranes is important at such times. Application of crane service to a number of locomotive and car repair jobs are shown in the illustrations.

Overhead carrying systems, such as the mono-rail, find more extensive utilization in the store room than in the locomotive shop. Stores departments that have large quantities of material to handle, have found a mono-rail system quite convenient in handling material from the piles or bins to the car door or loading platform.

The use of conveyor systems in railroad shops is confined primarily to power plants and to coal and ash handling at engine terminals. Some of the applications of conveyor systems to railroad shop work are also illustrated. From the standpoint of efficient engine terminal operation considerable delay can be avoided through the provision of adequate coaling and ash handling equipment. Conveyors of several types have been used successfully for unloading material from freight cars at the storeroom. A roller conveyor, consisting of wooden rollers turning on ball bearings, is being used by the Erie at a number of points on its system. In this conveyor the rollers are placed close together in a frame extending from the car to the place where the material is deposited. A slight incline from the car to the platform is sufficient to carry the material by gravity to the end of the conveyor. Corners can be turned quite successfully and for such work as moving packages, arch brick, etc., this type of conveyor is quite satisfactory.

Conclusion

Both the Mechanical Division V and the Purchases and Stores Division VI, A. R. A., have stressed the importance of providing not only an efficient system of material handling but adequate equipment as well. As a result there are few new shops built at the present time in which provision is not made for efficient handling of material. Old installations have also been improved through the installation of modern handling equipment and improved driveways for trucks, tractors and trailers.

The material used for driveways is important. Given in the table is the resistance per pound of moving load for various driveway surfaces. Concrete surfaced driveways give the least resistance to hauling and are coming into general use around railroad shops.

The utilization of cranes of practically all types is well understood as they have been an important part of railroad shop equipment for a good many years. Still many new applications, especially in the line of special types of equipment, have been developed in recent years that have tended to increase the services that may be performed by cranes in railroad shop work. The work that can be performed by trucks, tractors and trailers on hard surfaces has a wide range and new uses for such equipment are constantly being devised. These developments have tended materially to reduce the difficulties encountered in handling material due to a poor shop layout or inability to add fixed and less flexible facilities to the shop equipment, and have been a big factor in procuring increased shop efficiency.

Tractive resistance of various surfaces

Type of road surface	Resistance (Lb. per ton)
Brick, smooth	30 to 50
Concrete	28 to 40
Poor concrete	45 to 65
Granite blocks	50 to 60
Wood blocks	30 to 50
Gravel road, good condition	75 to 85
Clay	200 to 400
Wood planking	35 to 50
Wood planking, sticky surface	50 to 60

Welding high carbon tool and high speed steels*

By George L. Walker

Associate research engineer, Air Reduction Sales Company, New York

THE welding of high carbon tool steels and high-speed steels has an extensive field for development and one that has already met with considerable success. There yet remains a need for further study and development in methods and materials before these steels are as successfully and as extensively welded as are the lower carbon steels.

It is difficult to give a hard and fast rule for welding high-speed steels that will meet every demand. The piece that is to be welded, its design and purpose for which it is to be used as well as the chemical characteristics of the metal within the zone of welding, have an important influence on the welding procedure. The experience of the welder also must be considered. There are, however, some rules to be observed in welding these steels that are almost fundamental and which must be followed if any degree of success is to be realized.

High carbon tool steels are those steels containing from about 0.60 per cent carbon to 1.50 per cent carbon, and it is by reason of this high carbon content that they can be hardened and tempered and thereby serve in the cutting of metals. Such tool steels are used principally in making tools of various kinds, such as milling cutters, drills, reamers, files, lathe tools, saws, hammers, wrenches and for many other purposes where a tool possessing hardness and resistance to wear or abrasion is required.

High-speed steels are those steels of comparatively low carbon content which depend for their hardness on the use of tungsten and chromium. They also contain other metals, such as vanadium, cobalt, manganese and molybdenum. Such steels are used in making all kinds of tools, especially lathe and shaper tools, milling cutters, drills, reamers, and for all purposes where great efficiency, high-speed cutting and heat-resisting qualities are required.

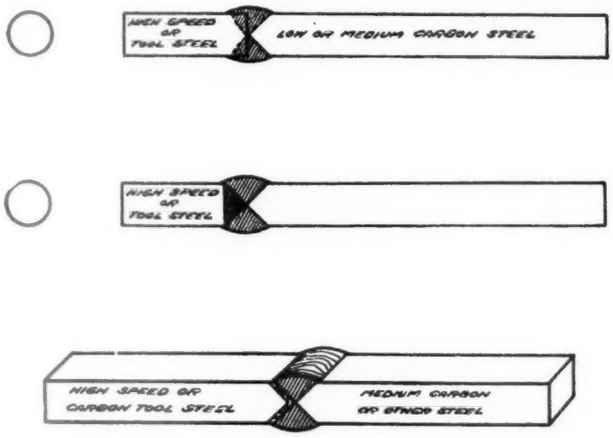
Importance of carbon content in tool steel

In the welding of tool steel the carbon content is an important factor to consider. A steel with a carbon content of from 0.60 to 0.85 per cent may be welded fairly easily by a welder who exercises ordinary care and is at all familiar with steel welding. With a carbon content of from 0.85 to 1.00 per cent the welding is more difficult, and from 1.00 to 1.50 per cent great care is required in making a weld—a degree of care that can only be attained by experience in welding steels with such high carbon content.

All metal cutting tools are subjected to a number of stresses, all of which are important factors in the proper

* Abstract of a paper presented before the New York Section, American Welding Society, May 18, 1926.

selection of the steel for the tool and also because of their effect on the welds. Drills, reamers and taps are subjected to torsion and to tension stresses. Lathe and shaper tools are subjected to transverse stresses. Milling cutters have to endure nearly every type of stress. The cutting edge of all metal cutting tools must not only have good wearing qualities, but because of its extreme fineness and its functioning in the cutting of metals must endure practically every stress. It is because of this fact together with the welding qualities of the metal that the welding of carbon tool steels and high-speed steels be-


HIGH SPEED OR TOOL STEEL
LOW OR MEDIUM CARBON STEEL
HIGH SPEED OR TOOL STEEL
HIGH SPEED OR CARBON TOOL STEEL
MEDIUM CARBON OR OTHER STEEL

Top—Welding high speed steel bits to medium carbon steel shanks for reamers and other tools; Bottom—Welding high speed or carbon tool steel to medium or other steel

comes a problem that has been harder for many welders to solve than the welding of mild carbon steel.

Both high carbon tool steels and high-speed steels have been and are now being welded successfully. In reclamation and general repair work much has been accomplished in such work as building up the faces of hammers worn and chipped in use. Wrenches with broken or worn jaws are being reclaimed. Milling cutters and reamers with broken teeth are repaired. Form tools are being reclaimed by building up the worn part with high-speed and tool steel and regrinding to shape.

Lathe tools for use in heavy cutting are being made by welding a high-speed steel bit to a medium carbon shank. Reamers are also made in this manner. Milling cutters and other steel cutting tools have been made by building up the cutting edge on a low chrome or medium carbon steel center.

Another use for both high carbon tool steel and high-speed steel is for building up parts of machinery, and so forth, which require a hard, erosion-resisting surface. In the welding of high-speed steels I wish also to include stellite, an alloy of cobalt, iron, chromium and tungsten which is used for similar purposes as are the high-speed steels.

Torch, tips and flame adjustment

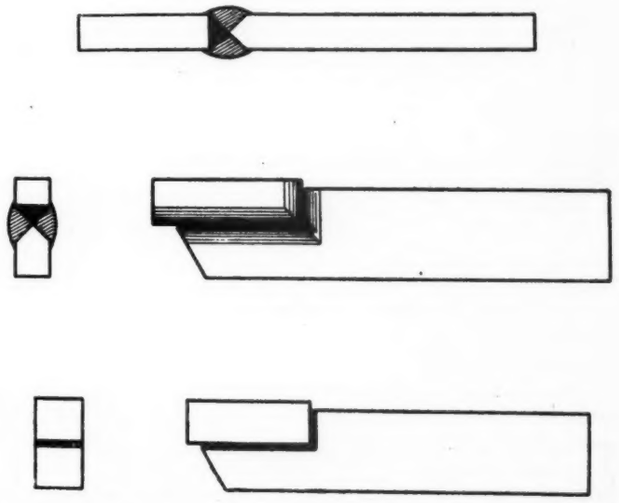
Among the main requisites in welding high carbon and high-speed steels are the torch and tips. They should be of a construction that will assure a good mixing of the gases before burning and a low gas ratio. Torches of this type are available.

The flame adjustment is also important. It should be a reducing flame for high-speed steels, stellite and the higher carbon steels. With the carbon steels this flame adjustment somewhat depends upon the carbon content. The lower carbon tool steels may be welded with a neutral flame, taking care that it is non-oxidizing. The higher carbon steels, however, require an excess of acetylene in the welding flame. It is difficult to describe the exact flame characteristic. Experience only can tell the welder the flame desired. It will vary slightly with the type of steel being welded.

The welding rod is also important. In the high carbon steels it should be of high-grade material, and not lower in carbon content than the steel to be welded. If the welding metal is to become part of the cutting edge it is preferable that the steel contain a slightly higher carbon content. This, however, is less important than that it be at least of as high a carbon content. Any great departure in the carbon content from that in the steel to be welded will make the welded metal either too soft to take the proper temper in the heat treatment, or too brittle to withstand the stress to which it will be subjected in use. There are many welds that can be made in tool steel where a much lower carbon steel can be used. This must be determined by the functioning of the tool itself, as these welds are at a point remote from the cutting edge.

In preparation of the part to be welded a rather wide bevel on tool steel is preferable. This will make unnecessary the fusing down of the sides in making the weld. All parts to be welded should be carefully cleaned of dirt and rust.

The welding of high-speed steels in general is not dissimilar to welding high carbon tool steel, requiring the same method of preparation and a welding rod that will flow freely and not cause blowholes. Heavy oxides from the chromium and tungsten usually form on the surface



Top—Method of welding high speed tool bits to soft steel shanks for lathe and shaper tools; Bottom—A method of brazing high speed steel bits to medium carbon steel shanks for lathe tools

of high-speed steels in the melting operation, and blowholes become difficult to eliminate. It will be found advantageous to use. wherever possible—and it is usually possible—a high-speed steel filler rod containing vanadium and cobalt. These steels flow freely and very cleanly. I do not mean to infer that this steel is a better high-speed steel than any other as undoubtedly each type of steel has its important field. I refer to its weldability only and value as a filler rod.

The tip for welding all tool steels should be from one to two or even more sizes smaller than should be used for the average steel of the same dimensions. This,

however, is controlled somewhat by the nature of the weld and the skill of the operator. But in general this rule holds good.

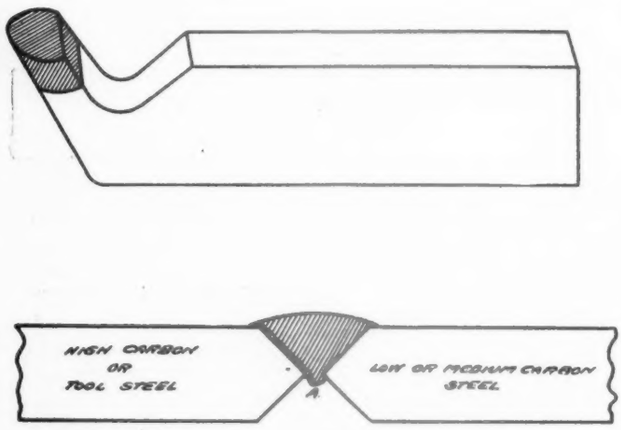
A flux is of great aid in welding tool steels; in fact, it is almost necessary in order to make good sound welds. A good cast iron flux will give good results on carbon tool steels. There are fluxes on the market that have been developed for tool steels.

Precautions to be observed

One of the main precautions to be observed in welding all of the tool steels is to take care not to overheat the welded metal. Do not use any more heat than is necessary. Another precaution is not to rework the welded metal unnecessarily. Deposit the filler rod in thin layers when the base is ready to make a weld. Add the metal just fast enough to prevent it from flowing over where the base is not in a welding condition and then let it remain there and add more filler rod. Continue in this manner until the weld is completed. It is the frequent reworking of the weld metal that causes the most of the defective welds. It causes blowholes, and creates an excessive film of oxide that collects on the surface. The success or failure of the weld depends on properly adding the filler rod.

When the welded joint is of the double vee type there will be some metal extended through the bottom of the vee when the first half of the weld is completed. This extended metal is composed to a great extent of oxides. It is better to remove this extended metal before starting the second half of the weld either by flowing it out of the vee with the torch or by any other means that will remove the oxide and prevent an excessive accumulation of it in the weld.

The high-speed steel should not be melted down in making a weld, but rather the filler rod should be added to the surface, taking care, of course, that the surface is



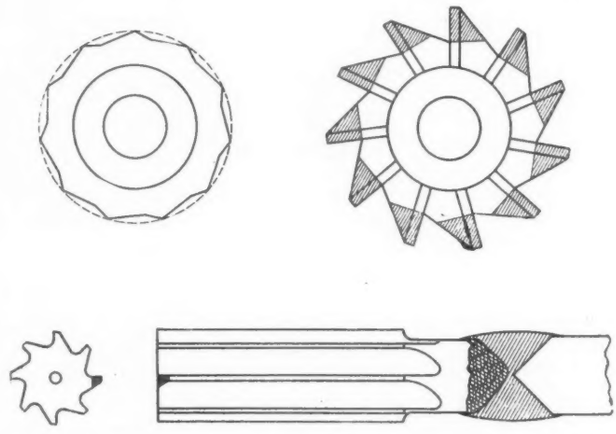
Top—The cutting edge on a lathe tool may be built up with high speed steel; Bottom—The metal and oxide extruding through the vee at A should be removed before welding the opposite vee

in the proper state of fusion to take a weld. For this reason a wide bevel is of great advantage. The bevel should not be less than 45 deg., and the combined vee not less than 90 deg.

Where a carbon tool steel or high-speed tool steel bit is welded to a medium carbon steel shank or base and it is not desirable or practicable to bevel the bit, it is best to prepare the bit first by building up over the surface a conical or beveled section with the filler rod. The filler rod should be of nickel or vanadium steel in a weld of this type. However, other steels may be used as the filler. The bit is then placed in position on the shank or base and the same filler rod used to make the weld.

I have seen many failures in making these welds when the bit was not prepared in this manner, but have always met with success when the bit has been prepared as I have just described. This type of weld is used on special reamers, heavy lathe and shaper tools, and so forth.

Lathe tools of the forged carbon tool steel type have been modified by building up the cutting ends with high-speed steel along the lines in the illustrations showing the lathe tool. Milling cutters have not only been repaired by building up broken teeth, but new cutters have been made by using a low chrome steel center and building up the teeth with the oxyacetylene flame. As an aid in this work a form or mold was made of graphite, approximating the shape of the teeth. The cutter base was mounted on a shaft or arbor so that it could be turned readily. The form was held in place and the weld made by carefully fusing the base and then filling up the form. These cutters were made in a short time and were suc-



The top view shows method of building up teeth on a milling cutter and the bottom view shows how a broken tooth on the end of a reamer may be built up and also the method of welding a broken shank

cessful. The filler rod was a cobalt high-speed steel. No heat treatment was required after welding. The cutter was ground into shape and put in service. In a test for comparison with a similar cutter made of high-speed steel by the casting process and a forged high-speed steel cutter the welded cutter gave approximately 60 per cent greater efficiency than the forged cutter, and about 30 per cent more than the one made by casting. The cutters used in the tests were 6 in. in diameter with a 1-in. face. The cut was 1 in. deep and was run at the highest speed possible. Identical results were obtained by the lathe tools built up as described.

Hammering of the weld after completion must be done with caution. It is beneficial to a weld in the carbon tool steels where the parts welded together and the filler rod are of the same composition, but where any part, including the deposited metal, is of a different type of steel or even of the same type, but considerably different in carbon content, hammering should not be attempted. Hammering of a weld where carbon tool steel is welded to low or medium carbon steel or to high-speed steel or where high-speed steel is welded to any other type of steel will cause the joint to break apart due to the difference in malleability of the metals. Many failures in welding these steels can be attributed to hammering the weld.

The Reader's Page

Have You a Question? Ask it
Have You an Opinion? Express it

Combustion the basis of front end design

SCHENECTADY, N. Y.

TO THE EDITOR:

Comment on front end design frequently implies that nothing rational has been done about the exhaust and front end problem and that a need exists for formulating the requirements for this feature of the locomotive.

In my study of this problem I have come to the following general conclusions: The exhaust and stack should be regarded as functioning with respect to the amount of fuel burned. This might be modified by taking account of the amount of steam formed but considering the steam formation as having a close relation to the amount of fuel burned, it serves no practical end to give it separate value. This, especially in view of the variable rates of combustion and steam requirements, can not be calculated too closely.

Primarily, I consider the jet to be one element and the stack another which should be proportioned to produce an ejector effect. With small locomotives this is a simple matter. The jet can be positioned far enough below the stack to catch the gasses and the stack can be of a length and flare that will produce efficient draft with no objectionable choking of the nozzle. When the locomotive reaches the clearance limit for the height of the stack together with the increased size of boilers, the present conditions are produced, with a stack which is mostly within the smoke box. When such conditions exist the proportions of the small locomotives cannot be retained. To offset this difficulty, the stack has to be relatively closer to the nozzle and the diameter must be reduced. The idea is to use the same size of cone as would develop into the proportionate size of stack that would be used if the clearance height were 40 ft. or 50 ft., instead of 15 ft. The ratio of the diameter of the boiler to the length should be kept within such limits as will not cause the loss of draft to be excessive. I think it has been shown that it should be 3½ diameters. Similar conditions require the exhaust to be sharper on account of the relatively close location to the bottom of the stack.

I have assumed a sliding scale of area of tip in relation to the total amount of steam flowing out which favors the small locomotive but does not change greatly from it. The stack diameters, owing to the great restriction imposed by the clearance height does not increase as fast as the outflow of the products of combustion and the greater portion of the taper lies within the smoke box. It is not difficult to do this and there appears to me to be no necessity for making the stack "extension" within the shell cylindrical, simply because it must be parted up near the top inside. Any locomotive requiring such a design of stack will permit sufficient variations in height at the bottom end without affecting the diameter, if only a foot or so be made without a taper.

I do not believe that the size of the cylinder need be taken into consideration. The proposition I make permits the size to be established with equal facility whether steam be used in cylinders or in a turbine, wherefore I consider it logical. A series of sizes has been worked out based on the general proportions of existing locomotives but using combustion as a basis without respect to the incident of cylinder diameter.

I wonder if others have used similar assumptions?

FRANK F. SCOVILLE.

Progressive car foreman should educate his car inspectors

DENVER, Col.

TO THE EDITOR:

In the editorial in the June issue, entitled "The car inspector's judgment," I heartily agree with the statement, "Improve the car inspector's judgment by careful training and frequent checks."

But why is it that so few car foremen are carrying on educational work among their car inspectors and the men who are to be their future car inspectors?

If we observe the work of the car department as I have through about 20 years of actual experience, I think that we can come to but one conclusion: that is, where we find the car inspector receiving the educational training so very necessary for his success, we find a progressive car foreman thoroughly experienced and up to date in car work. He realizes the fact that to make his own job a success by saving time and money for his company, he alone must educate his car inspectors to use expert judgment at all times.

You may ask, "what about the car inspector that education will not bring to the point where he can use expert judgment?" There are many car inspectors who were not cut out to use judgment and to assume the responsibilities required for a car inspector. So the progressive, experienced, live wire car foreman is the answer again. He soon locates through education and observation those men who are not fitted for car inspectors and places them on jobs of lesser responsibilities. If the higher railroad officers, in hiring and promoting car foremen, will first use some of this expert judgment themselves, the railroads will soon have plenty of car inspectors who can and will use expert judgment at all times.

In conclusion, I want to add just three questions on A. R. A. rules—practical questions from the ten to twenty that our chief and assistant chief joint inspectors figure out and put to their interchange inspectors every thirty days.

1—In handling a car with rider protection, if the hand brake becomes defective or inoperative before or during the switching operation and the car is damaged to the extent shown in Rule 44, who is responsible, the owner or handling line?

2—If a car is damaged on an incline track or wharf where rider protection is not furnished, who is responsible, the owner or handling line?

3—To what extent must a car be damaged where there is no rider protection when necessary, to make the damage a handling line responsibility?

A READER.

"Bill Brown" and "Top Sergeant"

Battle Creek, Mich.

To the editor:

You may be interested in the comments of my father, who lives in Stafford, England, on the "Bill Brown" controversy. Following is his reaction, quoting a few of his remarks in his own language:

"As I am over 70 years of age, my interest in the marked articles sent by you was mostly confined to the ever-changing relationship between employer and employee, or foreman and workman. Here 60 years ago a foreman was an autocrat, who ruled by the strength of his arms and it is more truth than fiction to say that he was invariably chosen for his fighting ability, knowledge of his job being only a secondary consideration. A suggestion by one of his men was always an insult and resulted in either a race or a fight.

"Looking back on those days, I must admit that the best results were often obtained by the best fist fighter and the best workers would invariably be found in his gang. Saturday nights the men would get together at some nearby saloon and boast about some feat of strength, or probably some brutal action their foreman was responsible for during the previous week.

"This was the type of workmen of that period and it is possible that the strong arm foreman was essential at that time. If 'Bill Brown' had been a foreman in those days and had requested instead of demanding, he would soon have been dubbed not 'Reverend' but 'Mrs. Brown' and would undoubtedly have lost both his prestige and the respect of that type of men.

"Compulsory school education was the main factor in pulling the teeth of the 'strong arm.' Our boys were taught to think for themselves. They began to write and express their thoughts intelligently to their fellow workers all over the country. The result was nation-wide organization, which has been instrumental in bringing him up to his present place in the sun.

"The time is approaching, if not already past, that class organization has outlived its usefulness. Note the tremendous losses to both sides, also to the public, in general, that have occurred in most of the industrial strikes during the past year or so. The result is that the contending forces have drawn a little further apart or distrust for each other has arose and the best intentions from either side are looked upon with suspicion.

"'Bill Brown' has recognized this deplorable condition and is paving the way to allay that suspicion by laying his cards on the table face up, admitting his weaknesses, recognizing both their weakness and strength, and seeking their co-operation.

"Education has taught the worker his power and he is going to use it for his own benefit. 'Bill Brown' also recognizes that power and he is going to use it for their mutual benefit.

"'Top Sergeant' is the type of foreman I am well acquainted with. He is trying to copy the strong-armed, stout-hearted foreman of 60 years ago, but look under his thin hide and you will find him only, what you call in America, 'a bluff.' We had him for a foreman on a tunnel job on the N. S. Railway. We were in about 1,000 yards when water began to soak through from an old abandoned coal mine. 'Top Sergeant' was appealed to for protection from caving by re-enforcing the side walls, but of course he ignored our appeal, drove us back to work by threats of discharge and told us we were paid for doing the work and he would do the thinking. However, he stooped low enough to tell us there was no danger, as he had figured it all out on paper.

"There was one man in the gang who was gifted with a sense of humor that often got him into trouble. He it was who connected a hose to a donkey pump and as 'Top Sergeant' was passing the weak place, turned a full flow of water on him. Poor old 'Top Sergeant' beat all known records getting out of that tunnel. Although he must have soon realized the trick, he never came back. His bluff had been called.

"Your 'Top Sergeant' will soon have his bluff called and he will never come back. Sixty years ago there was some excuse for his existence. Today, it is 'Bill Brown's' turn. Even if we give 'Top Sergeant' the benefit of the doubt and give him credit for giving all he is capable of to his job, what chance has he against 'Bill Brown' who is giving his best with the addition of the best that the men have who are working for him?" "Output."

A question on the Walschaert valve gear

St. Joseph, Mo.

To the editor:

If the pin should break or fall from the union link of a Walschaert valve gear, the locomotive running at a speed of 40 m.p.h., would the steam pressure in the cylinders cause them to break?

Such an instance of cylinder failure occurred on a locomotive operating in passenger service on the road with which the writer is connected. New cylinders, 19 in. by 36 in. had just been applied. I would like to have the opinions of the readers of the *Railway Mechanical Engineer* as to what might have caused this accident.

C. M. Lee.

Locomotives equipped with the Brotan firebox

Galveston, Texas.

To the editor:

On page 212, in the April issue of the Railway Mechanical Engineer, Louis A. Rehfuss refers to the possibility of a water-tube boiler displacing those of the usual locomotive type.

In principle, as well as in many details of construction, there is no difference between the latest form of the Brotan firebox and the McClellon and Muhlfeld designs now undergoing tests in the United States. It is evident, however, that Mr. Rehfuss is unfamiliar with the history and status of the Brotan type of firebox in Hungary. Instead of the 40 or 50 Brotan type boilers mentioned by him, there were at one time more than 600 boilers equipped with the Brotan water-tube firebox in use on the Royal Hungarian State Railways.

Among the classes of engines fitted, were the following:

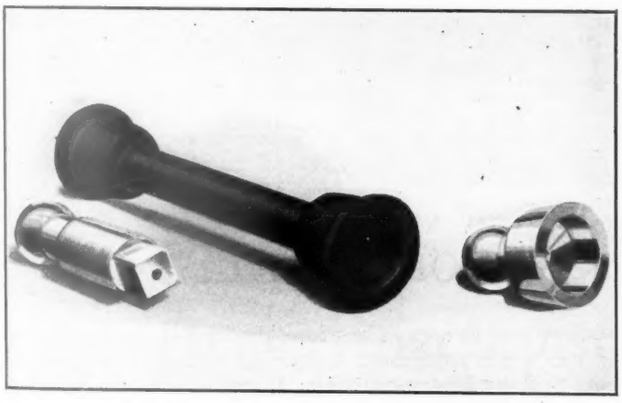
Number of locomotives	Series	Type
60	601	2-6 + 6-0 Mallet
158	328	4-6-0 Express
145	375	2-6-2 Tank
78	376	2-6-2 Tank

In addition to the above, the Brotan box was adopted as standard for at least eleven other classes of locomotives, ranging from the small 2-2-0 tanks to heavy 2-8-2 tank locomotives and the 2—4 + 4—0 Mallets.

As an indication of the practical results obtained from this large scale experiment, it is significant to note that when ten additional engines of series 376 were built in 1922 and 1923, water-tube fireboxes were not applied, and in 1924, 26 heavy 4-8-0 type express passenger locomotives of series 424 were constructed with ordinary radial-stay fireboxes. William T. Hoecker.

Pitkin articulated staybolt

WHEN the rigid type of staybolt was most generally used breakage was found near the outer sheet. This condition was because of the fact that the outer sheet, being heavier, held the end of the bolt in a rigid position, thereby throwing the greater



This view shows the middle member with its two sheet connections before assembly

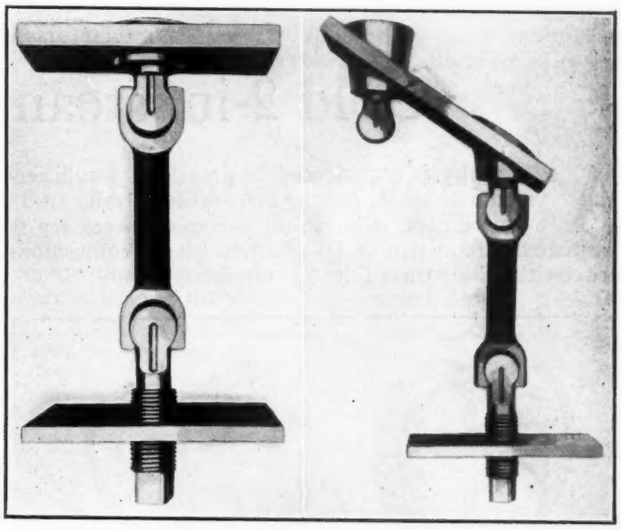
strain on the bolt at its junction with this sheet. The inner sheet, being of lighter weight, took up some of the strain by bending, thus partially relieving the bolt at the inner rigid connection.

This is the condition that brought about the development of the flexible staybolt. By the use of a flexible ball and sleeve type bolt the strain at the outer sheet was greatly relieved. However, the slightest movement still throws a strain on the thin inner sheet. The continued uneven expansion and contraction of the inner and outer sheets constantly changes their position in relation to each other. This movement causes the bolt to "bell" the hole on the water side, thereby exposing the thin threads to the oxidizing effect of the water.

The scale that forms around the bolts is also broken away by this weaving motion and fresh surfaces are exposed for attack. In time minute checks or cracks appear radiating from the bolt and finally the sheet is materially eaten away immediately around the bolt connection. This process continues until it becomes necessary to replace not only the bolt but also the sheet.

To relieve this condition it is necessary to provide means whereby the bolt connection to the firebox sheet can be held rigidly fixed therein and still have no weaving or bending strains set up at this point. In order to accomplish this result The American Locomotive Company, 30 Church Street, New York, has developed the Pitkin articulated staybolt.

One of the illustrations shows a partially sectional view of the bolt in order to show the reinforced bearing faces in the ends of the sockets as well as the expansion spaces in the sockets over the balls. Expansion stays have



At the left may be seen a partially sectional view of the bolt showing the reinforced bearings in the ends of the sockets —The right view shows a staybolt applied to a sheet with a maximum slope of 32 deg.

larger expansion spaces over the balls than water space bolts.

The connection at the outer sheet is a hollow tapered plug with a tell-tale hole drilled into the ball. A tell-tale hole is also drilled through the center of the inner threaded connection into the ball at this end of the bolt. The main bolt body and sockets are made substantially stronger than the end connections into the sheets, so that if a break

should occur, it would be immediately apparent through one of the tell-tale holes in the end connections.

Any movement of the articulated bolt body will only cause it to rotate around the ball located close to the thin sheet. By thus taking up the flexing strains set up by the relative expansion and contraction in the wrapper and inner firebox sheets, the life of the firebox sheets should be prolonged. As the actual movement between the outer and inner sheets is slight, the angular pull on the inner ball connection of the bolt is considered of no practical importance. This slight movement, however, will be sufficient to keep the joint free from the scale deposit which in some cases has transformed the semi-flexible into solid bolts.

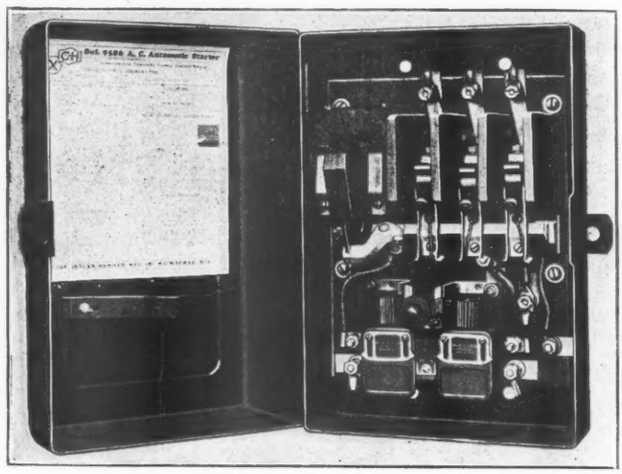
Across-the-line starters for A. C. motor drives

THE Cutler-Hammer Manufacturing Company, Milwaukee, Wis., has completed the design of an automatic starter for use in connection with alternating current motor drives, requiring motors of small and average capacities which can be connected directly across the line and provides complete motor protection.

These C-H "X" starters embody such features as small size, ruggedness of the switch mechanism, thermal overload relays, accessibility, and roominess in spite of the small size, low-loss magnet construction, easy installation and a wide range of application.

The type "A" starter in the "X" series is a fully enclosed starter and employs a positive acting three-pole contactor, together with a thermal overload relay. This relay is extremely accurate, can be adjusted to individual motor loads, and is of fool-proof design. After it has been tripped by an overload it is reset by pressing the reset button without the need of making any replacement. The contact fingers employed are easily accessible for inspection without the use of tools, and can be easily renewed. It is not necessary to take the starter from the case nor dismantle it.

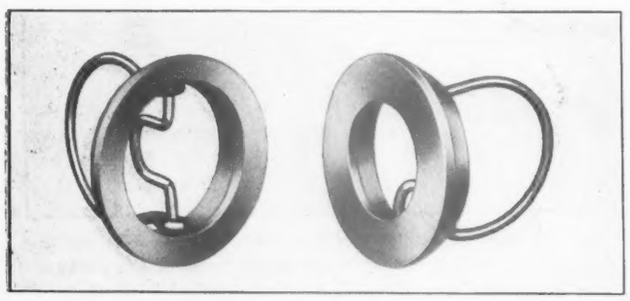
One starter takes care of all motor sizes, since only the heater coils need be changed to suit the ampere rating of the motor.



Automatic starter for use in connection with A. C. motor drives

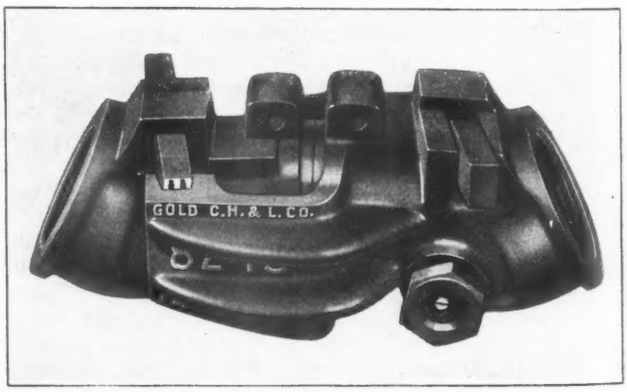
Gold 2-in. steam hose connection

AS difficulty is experienced in providing a sufficient volume of steam for the long modern trains of 14 or more cars, it is rapidly becoming necessary to eliminate the reduction to 1½ in. through the connections between the 2-in. train lines of adjoining cars.



The gasket at the left is for the 2-in. coupler and the one at the right is for use when coupling with the 1½-in. coupler

The Gold Car Heating & Lighting Company, 220 Thirty-sixth street, Brooklyn, N. Y., is now supplying 2-in. steam connections, including hose, couplers and end valves, which permit of unobstructed flow of steam from the locomotive to the rear end of the last car. The couplers which are constructed on the recommended contour lines will couple and lock with the present smaller couplers now in use. Therefore, the long passenger trains for which this equipment is intended can thus receive the benefit of the larger couplings at once before a complete change has been made on the remaining cars, with the assurance that should any cars find their way into other trains not so equipped, they will be interchangeable.



Method of locking the Gold 2-in. couplers

The increased weight of the coupler over the Gold 1½ in. size is but 14 oz. These couplers can be used with flexible metallic joints. In the construction of the

coupler head, the lines of the Gold No. 804S coupler have been followed. The new head is of malleable iron substantially ribbed to withstand hard usage. The wedge-shaped lock provides ample take-up for wear.

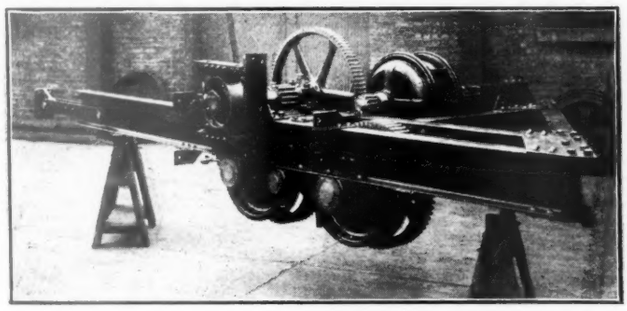
When in position for coupling the heads readily fit together and are steam tight. A tap from the inspector's hammer enters the wedge slightly over the accompanying toe to prevent lifting. It will be noticed that means are provided for the insertion of a link type lock, which can be supplied for locking with couplers of other types.

The gaskets used with the 2-in. couplers are of the oscillating type and are supplied in either Vulcabeston composition, or brass. They are furnished in two types, the standard 2-in. giving full opening, for use where all cars on any one train are equipped with the 2-in. connections. The second type, or the compromise gasket, provides a 1½-in. opening for use when coupled to the smaller couplers.

For the relief of condensation which lodges in the hose pockets between the cars, the No. 824S couplers are equipped with the Gold gravity traps. The internal pressure of steam in the coupler seats the valve and the trap is closed tight, there being no escape or leak, but the moment the pressure is relaxed, the valve, being heavier than the heads, falls away from the seat and all the water of condensation readily runs out, leaving the 2-in. supply line from the front to the rear of the train free for the passage of steam.

Two-wheel drive turntable tractor

GEO. P. NICHOLS & BROTHER, 2159 Fulton street, Chicago, has recently developed an improved type of turntable tractor which has two driving wheels and, therefore, is not effected by the tilting of the turntable to which it is attached. The connection to the end of the turntable is usually through a link. Turntable tractors with two driving wheels have been used for many years, but always with the disadvantage that the wheels and the tractor, was, therefore, forced by the motion of the table to travel in a circle with more or less side slipping and incidental wear and loss of power through friction.

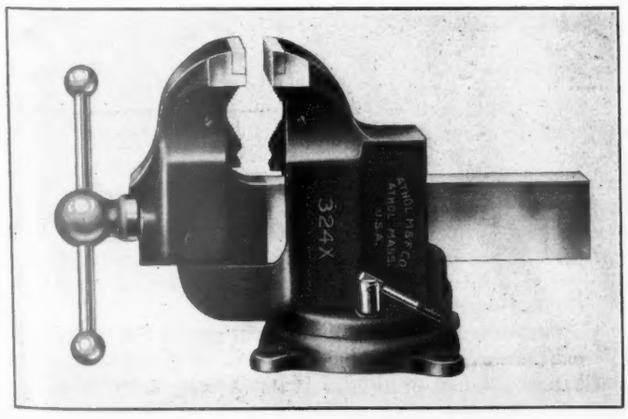


The Nichols two wheel drive turntable tractor with the operating cab removed

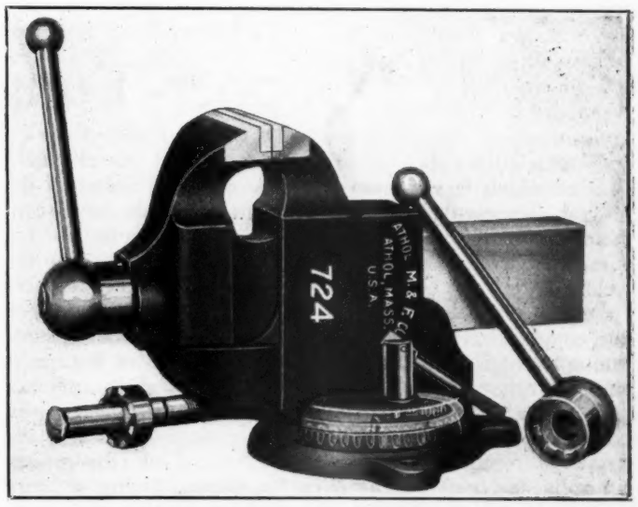
This tractor is designed and constructed with both of the driving wheels on radial axles that are radial and, therefore, the tendency is to run freely in a true circle without side slipping or loss of power. The drive from the motor to one of the traction wheels is identical with that on the Nichols single wheel tractor. The drive to the second wheel is through an equalizing pinion in the same plane with the two axles and with specially generated teeth, making it possible to use the standard driving gears on all installations, the pinion only being different. The tractor frame is made of 10-in. I-beams, the flanges being reinforced beneath all bearings so as to give no less than 1 in. of metal where the attaching bolts pass through.

Heavy machinists' and railway vises

THE vises shown in the illustrations, because of their weight and strength are known as heavy chipping vises. They are made of semi-steel castings, with tool steel jaw facings welded to the vise and hardened. These have deep corrugations on the faces to insure a firm grip. The swivel base vise has two corrugated clamp bolts, one on each side of the vise, which mesh with the corrugations in the circular runway of the swivel base, thereby locking the vise in any position desired. This fea-



The Athol combination pipe and machinists vise



A machinist vise provided with a swivel base

ture is of advantage when handling large pieces in the vise.

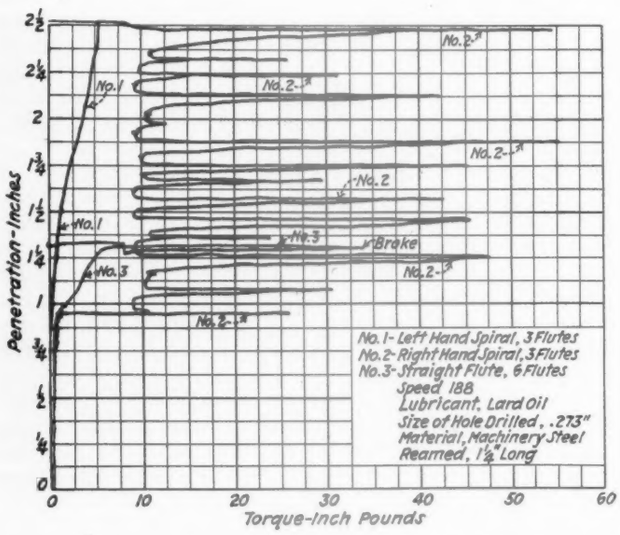
One of the illustrations shows a ratchet handle vise with a stationary jaw and swivel base which is suitable for the tool room. The ratchet handle is connected with the vise screw by a clutch in the handle and operates with a quick, positive action. After the vise is tightened the screw head is pulled out slightly, after which the handle may be placed where desired.

The other illustration shows a combination pipe vise, the jaws of which are made heavier than the regular vises in order to withstand the strain of the pipe work. The pipe grips are made of tool steel, machined from the solid bar and can easily be replaced when necessary. The pipe grips do not extend beyond the face of the vice jaws. This design increases the usefulness of the combination vise.

These vises are manufactured by the Athol Machine & Foundry Company, Athol, Mass.

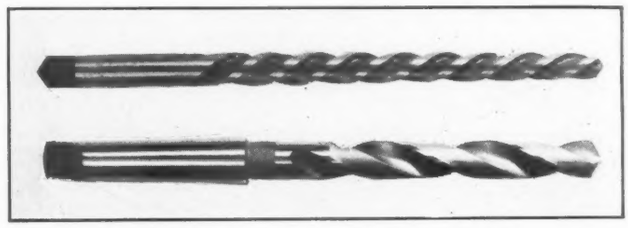
Drill and taper pin reamer—A correction

IN an article on page 386 of the June, 1926, *Railway Mechanical Engineer*, was given an account of tests of the three-flute taper pin reamer, of the Morse Twist Drill & Machine Company, New Bedford, Mass., comparing the performance of this reamer with reamers of the three-flute right-hand spiral type and the straight flute type.



Comparative torque test of the left hand spiral reamer, a right hand spiral reamer and a straight flute reamer

These tests were made on an Olsen autographic drill, tap and die testing machine in machinery steel in 1¼ in. long, feeding the reamer through a penetration of 2½ in., using the same time in each case. The article erroneously stated that the three-flute left-hand spiral reamer broke under a force of 5½ in.-lb., the straight flute reamer broke at 34 in.-lb., and the three-flute right-hand spiral reamer broke at 55 in.-lb. Reference to the graphic chart shows that only the straight flute reamer broke at a maximum torque of 34 in.-lb., while both the spiral reamers completed the operation intact. It will be seen, however, that the left-hand spiral flute reamer reached a maximum torque of 5½ in.-lb. and that this torque developed smoothly to a maximum at the maximum penetration of 2½ in., while the torque on the right-hand spiral reamer varied widely, reaching a maximum of 55 in.-lb. at approximately 1⅞ in. penetration and again just before the completion of the test. This chart clearly shows the free cutting action of the left-hand spiral reamer, which is shown at the top of the illustration herewith.



Bottom—Morse high speed forged type drill; Top—Taper pin reamer

Copper-Tungsten electrodes

COPPER-TUNGSTEN electrode, a development which is expected to prove of great value in the fabrication of metals, is now available for use in manufacturing. This announcement is made by the General Electric Company, Schenectady, N. Y., which developed the new electrode. One of the limiting features in many resistance or spot welding operations has been the copper electrode used, the pure copper not being hard enough when used under the high pressures at high currents common to this type of welding. Usually, after a few welds are made, the surface of the copper electrode in contact with the weld becomes hot enough to anneal the copper, thus making it very soft. As a result, the copper tip rolls and mushrooms over the edges, giving a large spot weld which changes the current density and, consequently, the quality of the work be electrically welded.

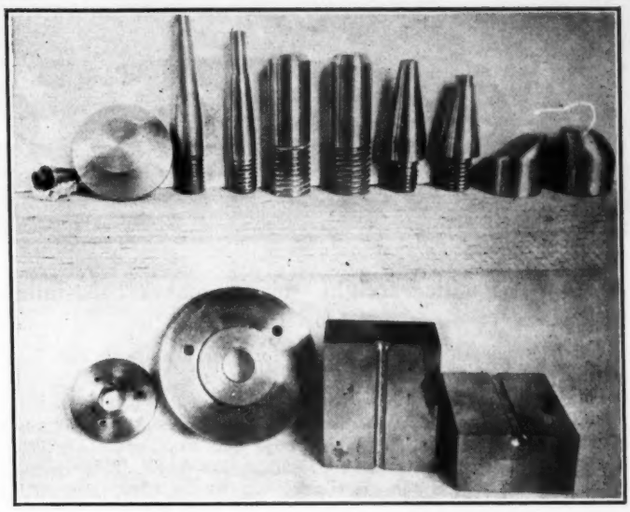
Copper-tungsten, as its name indicates, is a mixture of two metals—one a good electrical conductor and the other very hard. The alloy has a hardness of 225, Brinnell, as compared with 82 for hard copper and 30 for soft copper. The compressive strength of the copper-tungsten is 208,000 lb. per sq. in. as against 58,000 lb. per sq. in. for hard copper. The tensile strength is 56,350 lb. per sq. in., compared with 30,000 lb. for soft copper and 50,000 to 70,000 lb. for hard drawn copper.

Copper-tungsten does not anneal at red heat. Thus there is no soft surface metal to roll or mushroom when used in resistance welding. It has not been found necessary to form the entire electrode point or die of copper-tungsten, but rather to use inserts of this alloy by any one

of a number of methods, such as forcing an oversized piece in a hole in the die, brazing a block in the wearing surface or placing pieces in a mold and casting the die around them. The remainder of the die is made of copper as before.

In view of the higher first cost of copper-tungsten, its chief value is expected to be in special applications. It is particularly adapted for use under severe conditions where copper will not stand up. The durability of the new alloy is shown by a recent test, where the number of welds made with one dressing of a copper die averaged ten, while the first test using copper-tungsten inserts gave more than 1,000 welds with the die still in good condition at the end of the test. Other tests showed better results. It is therefore expected that the cost of changing the old copper electrodes and redressing them will more than pay for the larger first expenditure for copper-tungsten.

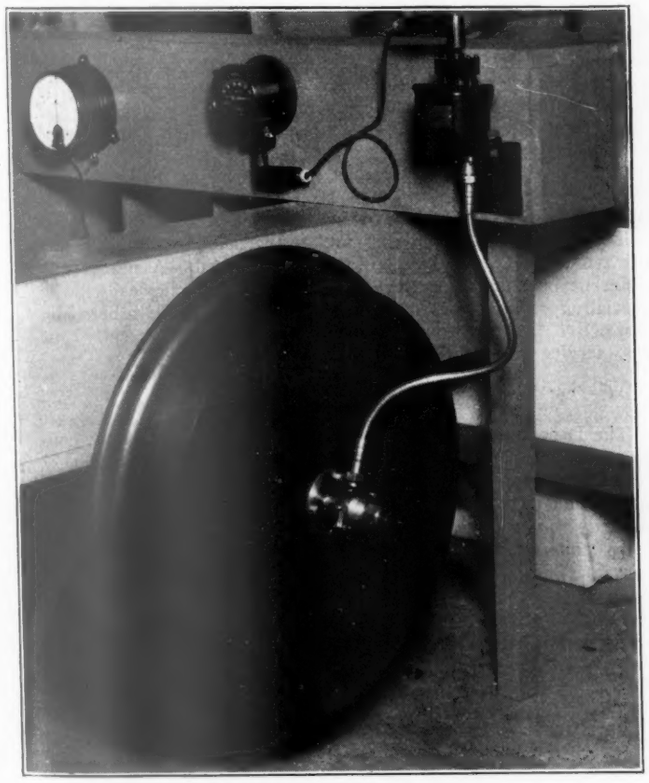
The material has been given the trade name Elkonite and will be manufactured and sold exclusively by the Elkon Works, Inc., Weehawken, N. J., of P. R. Mallory & Company.



Copper Tungsten electrode for electric welding

New magneto drive for locomotive tachometer

A NEW form of magneto drive has recently been developed by the Electric Tachometer Company, Philadelphia, Pa., in conjunction with the Westinghouse Electric and Manufacturing Company, Wilmerding, Pa., for the application of electric speed indicators to locomotives. This new drive permits the installation of an electric tachometer outfit in a few minutes, and eliminates the use of special gears, pulleys or belts.



Simplicity and ease of installation are claimed for this magneto drive

The outstanding feature of the new design is the method of driving the magneto from the locomotive wheel and the fact that this speed indicator operates independent of all other apparatus whereas previous designs were essentially attachments for use with train control. It has formerly been necessary to use special gears or a belt for this type of drive. The new drive eliminates the use of special attachments and also eliminates the possibility of lost motion in a slipping belt. It can be attached to any locomotive by the use of ordinary hand tools. The outfit is complete in itself.

The magneto is mounted with the shaft vertical on the framework above or adjacent to one of the leading wheels on the locomotive. A small gear box is attached to the end of the locomotive axle, outside of the wheel. Only three small tapped holes in the axle are necessary for mounting. A short length of flexible shaft connects the gear box to the magneto. The gear box contains a pair of bevel gears. One of these is attached to the locomotive axle and the other is mounted in a housing which is free to revolve around the first bevel gear as a center. The flexible shaft is attached to the second bevel gear and prevents actual rotation of the housing, although a small amount of motion is permissible. In action, the housing remains stationary and the gears revolve, transmitting motion through an angle of 90 deg. to the flexible shaft and magneto. This construction reduces the transmission problem to its simplest form and takes care of all movements of the locootive wheels with respect to the locomotive frame. It allows the magneto to be rigidly mounted, as its heavy construction requires, and at the same time provides a positive drive which is independent of various wheel positions.

THE ILLINOIS CENTRAL has ordered 50 2-8-4 type locomotives from the Lima Locomotive Works. These are duplicates of the Lima A-1 locomotive and will have 28 in. by 30 in. cylinders, 63 in. diameter driving wheels, 240 lb. boiler pressure. They will have a booster-equipped four-wheel articulated trailer truck, which makes possible one hundred square feet of grate area. The approximate total weight of one of these engines in working order will be 385,000 lb.

News of the Month

Missouri Pacific freight train makes 162-mile non-stop run

What is believed to be a world record for a non-stop trip by a heavy tonnage freight train was made by the Missouri Pacific on May 3, when Train No. 68 left Kansas City, Mo., at 5:20 p. m. with engine 1498, a stoker-fired coal-burning locomotive, in charge of Conductor J. W. Rutledge and Engineman W. W. Young, with Dispatcher J. T. Neal at the key. This train, with 57 loads, 2,455 tons, arrived at Jefferson City, Mo., 162 miles from Kansas City, at 11:15 p. m., making the run in 5 hr. 55 min. without making a stop in the entire distance. An auxiliary tank holding 10,000 gal. of water was provided to avoid the necessity of stopping for water, while the one tank of coal taken at Kansas City was sufficient to take the train through. Similar tanks are being used on other freight trains in this district to avoid the necessity of stopping for water.

Equipment installed

Class I railroads in April placed in service 10,617 freight cars, according to reports filed with the Car Service Division of the American Railway Association. This brought the total number of cars placed in service this year to 31,980, as compared with 57,926 during the corresponding period last year and 46,421 during the same period in 1924. Of the cars now reported 5,791 were box cars, 3,541 coal and 855 refrigerator.

Freight cars on order on May 1 totaled 48,762, compared with 43,301 on the same date last year and 68,019 on the same date in 1924. These included 21,259 box, 19,987 coal and 5,230 refrigerator cars. Class I railroads during April also installed in service 189 locomotives, which brought the total number placed in service up to 759. During the first four months last year 601 locomotives were installed in service and during the same period in 1924 there were 758. Locomotives on order on May 1 this year amounted to 654 compared with 340 on the same date last year and 552 on the same date two years ago.

These figures as to freight cars and locomotives include new and leased equipment.

Safety program for July

L. G. Bentley, chairman of the committee on education of the Safety Section of the American Railway Association, in circular No. 127, has issued the program to be followed during the month of July in the general campaign to reduce by 35 per cent, before the year 1931, the total number of casualties to railroad employees, as compared with 1924. His text is taken from the first paragraph of the "general notice" of the standard code of train rules: "SAFETY IS OF THE FIRST IMPORTANCE IN THE DISCHARGE OF DUTY"; a reminder that this subject was prominent in railroad life long before the beginning of the modern "safety-first" movement. Circular 127 deals with the necessity for rules; with the selection and training of new employees, and hints as to how to deal with violations of rules. The following points are set forth as the qualifications which should be sought in a workman when looking for candidates for a foremanship:

1—A conscientious desire for a safe administration.
2—Ability to win the regard and respect of subordinates.
3—Knowledge of the business to be supervised.
4—Ability to systematize.
5—Vision for development.

Switchers give thirty days continuous service

Four locomotives of the Terminal Railroad Association of St. Louis, during a recent test, were kept in continuous service for a period of 30 days without having any of the fires cleaned. These locomotives, equipped with Hulson grates, were assigned to heavy transfer service, being handled by regular crews on three shifts. At no time were the fires cleaned, their condition being kept good by shaking the grates regularly, at intervals depending upon the amount of fuel burned. Ash pans were dumped every eight hours, at the time of changing crews. At the end of the 30-day test period, the fires were in good condition and apparently could have been continued indefinitely but for the necessity of dumping to permit boiler washing. This test showed a large saving in fuel, as it is estimated that every time a fire is cleaned, about 500 lb. of coal is required to restore normalcy; formerly 16 hours was the average time between fire-cleaning periods. In a large system of busy terminals like St. Louis, having 200 switching locomotives, continuous service throughout the 24-hour period is essential, and there is no intermission in which repairs or service requirements may be performed as in road service.

Pennsylvania places orders for locomotives and dining cars at its Altoona works

The Pennsylvania Railroad, as part of its equipment program for 1926, has placed orders at its Altoona works for 60 six-wheel medium weight switching locomotives, known as class B6sb, for general service, and 24, 70-ft. all-steel dining cars of the latest type, class D78b.

These are in addition to orders recently placed with outside builders for 200 road locomotives for express passenger or fast freight service, and 234 all-steel passenger train cars of various classes.

The class B6sb locomotive has cylinders 22 in. diameter with 24 in. stroke. The driving wheels are 56 in. diameter. Including tender, the weight in working order is 305,300 lb.

The class D78b dining cars are of the same general plan as the ten diners which have just been completed. A number of different interior decorative designs and color schemes will be specially prepared for some of these cars, while in others the distinctive interior designs employed in the cars recently put into service will be repeated.

Consumption of babbitt metal

The Department of Commerce announces a total apparent consumption of babbitt metal, based on reports received from 27 firms, as 5,229,199 lb. in April, as compared with 5,860,543 lb. in March and 5,126,416 in April, 1925. This consumption is calculated from sales by manufacturers and consumption by those firms, among which are several important railroad systems, who consume their own production. In the following table the sales of babbitt metal are shown separately from the consumption in the producing plants:

1925	Total apparent consumption	Sales by manufacturers	Consumption by producers
January	5,683,183	4,620,815	1,062,368
February	5,164,619	4,103,340	1,061,279
March	5,644,288	4,395,901	1,248,387
April	5,126,416	3,928,136	1,198,280
May	5,081,668	4,189,558	892,110
June	5,074,966	4,085,125	989,841
July	5,184,196	3,694,386	1,489,810
August	5,441,823	4,068,706	1,373,117
September	4,621,033	3,579,780	1,041,253
October	5,550,247	4,169,870	1,380,377
November	4,954,683	3,534,026	1,420,657
December	4,878,806	3,910,160	968,646
Total	62,405,928	48,279,803	14,126,125
1926			
January	5,152,694	3,708,383	1,444,311
February	5,139,952	3,867,710	1,272,242
March	5,860,543	4,852,805	1,007,738
April	5,229,199	3,817,253	1,411,946
Total (4 mos.)	21,382,388	16,246,151	5,136,237

Meetings and Conventions

Twenty-fifth anniversary of Car Foremen's Association

The meeting of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, to be held at the Hotel Sherman, Chicago, September 21, 22 and 23, will be the twenty-fifth anniversary of the association, and plans are being made by the Executive Committee to make it the largest ever held. Many prominent speakers will be on the program, and a special souvenir booklet, giving a complete record of the association from its inception in 1901 to date, with a complete list of the membership, will be printed for the occasion.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs.

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—C. Borcherdt, 202 North Hamlin Ave., Chicago.

AMERICAN RAILWAY ASSOCIATION, DIVISION V.—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

DIVISION V.—EQUIPMENT PAINTING SECTION.—V. R. Hawthorne, Chicago. Next meeting September 21-23.

DIVISION VI.—PURCHASES AND STORES.—W. J. Farrell, 30 Vesey St., New York.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—G. G. Macina, 11402 Calumet Ave., Chicago. Annual convention September 1-3, Hotel Sherman, Chicago.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, Marion B. Richardson, associate editor, *Railway Mechanical Engineer*, 30 Church St., New York.

AMERICAN SOCIETY FOR STEEL TREATING.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 20-24, Municipal Pier, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andrucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill. Annual meeting October 27-30, Chicago.

BIRMINGHAM CAR FOREMEN AND CAR INSPECTORS' ASSOCIATION.—P. H. Gillean, 715 South Eightieth Place, Birmingham, Ala. Meeting second Monday in each month at Birmingham Y. M. C. A. Building.

CANADIAN RAILWAY CLUB.—C. R. Crook, 129 Charron St., Montreal, Que. Regular meetings second Tuesday in each month, except June, July and August, at Windsor Hotel, Montreal, Que.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.—R. E. Giger, 721 North 23rd St., E. St. Louis, Ill. Meetings, first Tuesday in month, except June, July and August, at the American Hotel Annex, St. Louis.

CAR FOREMEN'S CLUB OF LOS ANGELES.—J. W. Krause, 514 East Eighth St., Los Angeles, Cal. Meeting second Friday of each month in the Pacific Electric Club Building, Los Angeles, Cal.

CENTRAL RAILWAY CLUB.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Regular meetings, second Thursday each month, except June, July and August. Hotel Statler, Buffalo, N. Y.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—A. S. Sternberg, Belt Railway. Clearing Station, Chicago. Convention September 21, 22 and 23. Hotel Sherman, Chicago.

CINCINNATI RAILWAY CLUB.—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meetings, second Tuesday, February, May, September and November.

CLEVELAND STEAM RAILWAY CLUB.—F. L. Frericks, 14416 Adler Ave., Cleveland, Ohio. Meetings first Monday each month except July, August and September, at Hotel Hollenden, East Sixth and Superior Ave., Cleveland, Ohio.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich. Next convention August 17-19, Hotel Winton, Cleveland, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. B. Hutchinson, 1809 Capitol Ave., Omaha, Neb.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabash Ave., Winona, Minn.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 26 Cortlandt St., New York.

NEW ENGLAND RAILROAD CLUB.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Regular meeting second Tuesday in month, except June, July, August and September. Copley-Plaza Hotel, Boston, Mass.

NEW YORK RAILROAD CLUB.—H. D. Vought, 26 Cortlandt St., New York. Meetings third Friday in each month, except June, July and August, at 29 West Thirty-ninth St., New York.

PACIFIC RAILWAY CLUB.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Regular meetings, second Thursday of each month in San Francisco and Oakland, Cal., alternately.

RAILWAY CLUB OF GREENVILLE.—F. D. Castor, clerk, maintenance of way department, Bessemer & Lake Erie, Greenville, Pa. Meeting last Friday of each month except June, July and August.

RAILWAY CLUB OF PITTSBURGH.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Regular meeting fourth Thursday in month, except June, July and August. Fort Pitt Hotel, Pittsburgh, Pa.

ST. LOUIS RAILWAY CLUB.—B. W. Frauenthal, Union Station, St. Louis, Mo. Regular meetings, second Friday in each month, except June, July and August.

SOUTHEASTERN CARMEN'S INTERCHANGE ASSOCIATION.—J. E. Rubley, Southern Railway Shops, Atlanta, Ga.

TEXAS CAR FOREMEN'S ASSOCIATION.—A. I. Parish, 106 West Front St., Fort Worth, Tex. Regular meetings, first Tuesday in each month. Terminal Hotel Bldg., Fort Worth, Tex.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio. Annual meeting September 14-17, Hotel Sherman, Chicago.

WESTERN RAILWAY CLUB.—Bruce V. Crandall, 226 W. Jackson Blvd., Chicago. Regular meetings, third Monday in each month, except June, July and August.

Supply Trade Notes

E. Theodore Sproull, assistant to the president of the Trumbull Steel Company, Warren, Ohio, has resigned.

The American Hoist & Derrick Company plans the construction of a one-story machine shop at St. Paul, Minn.

The Minwax Company, Inc., has removed its office from 10 East Huron street to 230 East Ohio street, Chicago.

H. C. McClary, vice-president of the Fairbanks Morse Company from 1907 to 1917, died at Evanston, Ill., on May 30.

Eagle-Picher Lead Company has moved its Chicago office from 208 South La Salle street to 134 North La Salle street.

Delbert C. Davis and Charles L. Kenyon have been appointed assistant treasurers of the General Electric Company, Schenectady, N. Y.

The American Steel Foundries, Chicago, has removed its St. Louis, Mo., office from 729 Frisco building to 1717 Railway Exchange building.

The Timken Roller Bearing Company will spend $1,500,000 to expand its Canton, Ohio, plant including enlarged laboratory and research facilities.

The Sullivan Machinery Company has moved its northwestern sales office from the Hutton building, Spokane, Wash., to 120 South Lincoln street.

The American Steel & Wire Company has opened a district office for Oklahoma and Kansas at 217 Atlas Life building, Tulsa, Okla., in charge of George F. Bell.

D. A. Corey, vice-president of S. F. Bowser & Co., Fort Wayne, Ind., has resigned. R. E. Lounsbury has been appointed industrial sales engineer, with headquarters at Albany, N. Y.

L. Gerald Firth has been appointed general manager, and R. S. Stevick works manager of the Firth-Sterling Steel Company, McKeesport, Pa. Mr. Firth was formerly works manager and Mr. Stevick his assistant.

The Chicago Steel Tank Company has leased 213,000 sq. ft. of ground with option to purchase at 6600 South Narragansett avenue, Chicago, on which it plans the erection of a plant which will be ready for occupancy in the fall.

Redmond F. Kernan has resigned as an officer and director of the Regan Safety Devices Company, Inc., New York, and Joseph Beaumont, vice-president and sales manager, has been elected director to fill the unexpired term.

W. H. Haile, district manager of the National Carbon Company, with headquarters at Pittsburgh, Pa., has been appointed manager of the railway sales division of the National Carbon Company, Inc., and the Prest-O-Lite Company, Inc., with headquarters at Cleveland, Ohio.

L. G. Plant has been appointed sales agent for special applications of coal, ash and sand handling equipment of the Ogle Construction Company, Chicago, Ill. Mr. Plant will continue also to represent the Locomotive Terminal Improvement Company as general sales agent for the direct-steaming system.

The Union Asbestos & Rubber Company has completed a new plant at Cicero, Ill., to manufacture a large variety of asbestos products bearing the Unarco trade mark. The plant covers a ground area of 175,000 sq. ft., with a factory floor space of over 100,000 sq. ft., exclusive of 20,000 sq. ft. of warehouse space.

Francis T. West, who has been the western manager of the Watson-Stillman Company, with headquarters in Chicago, for the past 25 years, has retired and has been succeeded by J. F. Coyne, with offices at 549 West Washington boulevard, Chicago, Ill. Associated with Mr. Coyne in the handling of the hydraulic machinery and accessory lines of the Watson-Stillman Company are James T. Lee and John O. Clark.

Lawrence A. Luther, for seven years with the Delaware, Lackawanna & Western, has joined the Ingersoll-Rand organization, having reported to the Chicago office on May 10. He will look after the servicing of Ingersoll-Rand pneumatic tie tamper equipment in use by the railroads of the middle-western territory.

Charles Leslie Rise, assistant works manager at the Hawthorne Works of the Western Electric Company, has been appointed works manager of the Hawthorne works, Chicago, in charge of all its manufacturing functions there. S. S. Holmes is now assistant works manager. Mr. Rice succeeds to the position formerly held by G. C. Stoll.

H. Allen Faust, Philadelphia, Pa., who has been covering the state of Pennsylvania, including the Philadelphia district and southern New Jersey, as salesman of brass pipe and tubular plumbing goods for the Bridgeport Brass Company, Bridgeport, Conn., has had his territory increased by the addition of Maryland, West Virginia and Washington, D. C.

Thomas O'Malley, president of the O'Malley-Beare Valve Company, Chicago, whose sudden death from heart failure occurred on May 14, was born in Jackson, Tenn., on October 12, 1875. He entered railway service as a call boy for the Illinois Central at Jackson, Tenn., in 1885, and in 1887, at the age of 12, he was appointed an operator, which position he held until 1903 when he was appointed dispatcher at Fulton, Ky. He held the latter position until 1909 when he was promoted to trainmaster of the Birmingham district of the Illinois Central, with headquarters at Jackson, Tenn., which position he held until 1910 when he resigned to become vice-president of the O'Malley-Beare Valve Company which he and his brother, Edward O'Malley, organized. He held the position of vice-president until March 17, 1926, when he was elected president.

Thomas O'Malley

The Cecil R. Lambert Company, Inc., Detroit, Mich., specialists in the design, manufacture and installation of conveying and handling equipment, in order to identify its products and service with its name, has changed the latter to Mechanical Handling Systems, Inc. The company's facilities for service are being materially increased by additions to its plant and personnel, but there is no change in ownership, management or executive staff.

The draft gear activities of the Westinghouse Air Brake Company have been taken over by the Westinghouse Friction Draft Gear Company, with sales headquarters at Room 913, Peoples Gas building, Chicago. H. B. Gardner, formerly a representative of the Westinghouse Air Brake Company, with headquarters at New York, has been appointed general sales manager of the Westinghouse Friction Draft Gear Company, with headquarters at Chicago.

Francis Hodgkinson, for many years chief engineer of the South Philadelphia Works, Westinghouse Electric & Manufacturing Company, has been appointed consulting mechanical engineer for the organization as a whole. The position of chief engineer of the South Philadelphia Works has been discontinued. A. D. Hunt has been appointed manager of engineering, a newly created position. He has for many years been a member of the engineering staffs of the Westinghouse organization, headquarters of which is located at Wilmerding, Pa.

The Jos. W. Hays Corporation, Michigan City, Ind., manufacturers of draft gages, flue gas analyzers, CO_2 recorders, and other combustion instructions, has changed its name to the Hays Corporation. Jos. W. Hays, who founded the business in 1907, has disposed of his entire holdings in the company in order to devote all of his time to his practice as a consulting engineer. Philip T. Sprague, the new president, was for a number of years vice-president and general manager of the Jos. W. Hays Corporation.

The Graybar Electric Company has signed a contract leasing the entire fifteenth floor of the proposed large office building to be located adjacent to the Grand Central Terminal, facing Lexington avenue and situated between Forty-third and Forty-fourth streets, New York. The new structure is known as the Graybar building, taking its name from the Graybar Electric Company. The building occupies over an acre and a half of ground. The Buffalo, N. Y., branch office of this company has been moved from 709 Main street to 77-79 Swan street.

G. W. Curtis, industrial equipment engineer of the Timken Roller Bearing Service & Sales Company, has been promoted to district manager of sales, Industrial division, with headquarters at Milwaukee, Wis., and will be succeeded by S. M. Weckstein. G. W. Richards and A. R. Spicacci have been appointed assistant industrial equipment engineers. H. E. Gilmore, representative of the Timken Roller Bearing Service & Sales Company, with headquarters in Chicago, has been appointed manager of the St. Louis branch. The Omaha branch office of this company has been moved from 2524 Farnum street to 2240 Douglas street. The Los Angeles branch has been moved from 1241 South Hope street to 1361 South Figueroa street.

Richard R. Harris has been appointed general manager of sales of the Pittsburgh Steel Company, Pittsburgh, Pa., and subsidiary companies which include the Pittsburgh Steel Products Company and the National Steel Fabric Company. Mr. Harris has been general manager of sales of the Pittsburgh Steel Products Company for about twenty years. George W. Jones, who has been assistant general manager of sales of the Pittsburgh Steel Company, has been appointed manager of sales, succeeding John F. Hazen, resigned. Charles F. Palmer, who has been manager of the Chicago office of the Pittsburgh Steel Products Company, has been appointed manager of sales of this company, and Edward L. Benedict continues as vice-president and manager of the sales department of the National Steel Fabric Company.

Lawrence K. Diffenderfer has resigned as secretary and treasurer of the Vanadium Corporation of America. Mr. Diffenderfer has left the Vanadium Corporation of America to engage in special accounting, tax work, industrial plant and mine valuation, and work of that nature. He has been succeeded by Edgar R. Alpaugh. P. J. Gibbons, chief clerk of the Bridgeville plant of the Vanadian Corporation of America, has been elected assistant treasurer. J. A. Miller, Jr., general sales engineer, has become assistant general manager of sales, with headquarters in New York. H. T. Chandler, assistant to the president, formerly located in Detroit, has been transferred to the New York office, in the same capacity. C. N. Dawe, formerly with the Studebaker Corporation of America, at Detroit, has become manager of the automotive division, with headquarters in Detroit, and T. N. Bourke, district sales manager, has become assistant manager of the automotive division, with headquarters in Detroit.

The Baldwin Locomotive Works has acquired a majority interest in the Midvale Company. The purchase was on a cash basis and no financing will be required. The Midvale Company owns the Nicetown plant, in Philadelphia, Pa., which was not included in the sale several years ago, of the Midvale Steel & Ordnance Company to the Bethlehem Steel Corporation. The Nicetown plant manufactures structural steel, ordnance, locomotive forgings, steel tired wheels and other iron and steel products. The Midvale Company's business will be continued as usual and it will increase its line of products so as to fit in with the Baldwin organization. There will be no change in the management of the Midvale Company. Samuel M. Vauclain will continue as chairman of the board and Alva C. Dinkey as president. Acquisition of the company will involve no change in the Standard Wheel Works at Burnham, Pa., or in the development of the Baldwin plant at Eddystone. The Midvale Company owns the entire capital stock of the Midvale-Philadelphia Company, operating warehouses in Cleveland, Chicago, San Francisco and Philadelphia.

Trade Publications

HAND OVERHEAD CRANES.—Book No. 104, giving the dimensions of a few standard types of Morris hand overhead cranes and showing their use in various industries, has been issued by Herbert Morris, Inc., Buffalo, N. Y.

ANTI-SLIP TREADS.—A leaflet descriptive of Feralun anti-slip treads and showing their structural application to several types of coach steps has been issued by the American Abrasive Metals Company, 50 Church street, New York.

PNEUMATIC RIVETERS.—The Hanna Engineering Works, 1765 Elston avenue, Chicago, has issued a bulletin descriptive of its pneumatic riveters and featuring the dependability of riveted steel for locomotives and cars, bridges, etc.

MODULATING VALVE.—A four-page illustrated folder descriptive of the Jenkins modulating radiator valve for one or two-pipe low pressure steam, vacuum and vapor heating has been issued by Jenkins Bros., 80 White street, New York.

NICKEL CAST IRON.—Bulletins Nos. 201 and 202 describing the properties and applications of nickel and nickel-chromium cast iron and the improving of gray cast iron with nickel, respectively, have been issued by the International Nickel Company, 67 Wall street, New York.

AIR COMPRESSORS.—The Sullivan belt-driven, wafer valve air compressors, Class WG-6, single-stage, and Class WH-6, two-stage, are illustrated and described in the second edition of Bulletin No. 83-B which has been issued by the Sullivan Machinery Company, 122 South Michigan avenue, Chicago.

TURRET LATHES.—Two booklets descriptive of the new Gisholt full swing side carriage turret lathes have been issued by the Gisholt Machine Company, Madison, Wis. One booklet describes the 3L and 4L lathe having a fixed center turret; the other, the 3L and 4L machine having a cross feeding turret.

WELDING AND CUTTING EQUIPMENT.—A miniature catalogue, No. 172C, of Milburn welding and cutting apparatus has been issued by the Alexander Milburn Company, 1416 West Baltimore street, Baltimore, Md. The catalogue contains 32 illustrated pages and a list of a few representative users of the equipment.

ELECTRIC PORTABLE HOISTS.—The Sullivan Machinery Company, 122 South Michigan avenue, Chicago, has issued Bulletin No. 76-G descriptive of the HE and HE-2 single drum, and the HDE double drum electric portable hoists which are designed for use where electric wires are strung to the work to be done, or when air power is not available.

TRANSFORMERS.—The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has issued a four page leaflet, L. 20288, descriptive of the application, construction and distinctive features of its new shovel type transformers which are designed with leak proof bushings and tanks. Several illustrations and a tabulation of outline dimensions are also given in this leaflet.

DIESEL ENGINES.—Three bulletins descriptive of Diesel engines have been issued by Fairbanks-Morse & Co., Chicago. Bulletin No. 1010 describes the economy of Diesel engine power; Bulletin No. 1020 gives a comparison of Diesel engine principles, and Bulletin No. 1031 describes the construction and operation of the Type Y, Style VA, oil engine. Each of the bulletins is attractively arranged and well illustrated.

VERTICAL TURRET LATHE.—Specifications for the 54-in. New Era type of vertical turret lathe, having one swivel turret head and one non-swiveling side turret head, are given in Circular VT—3-54 which has just been issued by the Bullard Machine Tool Company, Bridgeport, Conn. This circular announces several changes and improvements which affect also the complete line of vertical turret lathes manufactured by the Bullard Company.

M-R-C THRUST BEARINGS.—Dimensions, load ratings and price lists covering M-R-C thrust bearings are given in a 36-page catalogue which has been issued by the Marlin-Rockwell Corporation, Jamestown, N. Y. These bearings are made single-acting or double-acting to compensate for end thrust loads acting in either one or two directions. They are designed to support end thrust loads only; that is, loads acting parallel to the axis of rotation.

VALVES.—Valves suitable for almost any condition encountered in industries using water, air, steam, acids, oils, heavy liquids, oil residue, high hydraulic pressures, etc., are listed in catalogue No. 33 issued by the Homestead Valve Manufacturing Company, Homestead, Pa. A complete line of plug type valves is shown, also several new products including the full round opening valve, the protected seat globe valve, the protected seat hydraulic operating valve, and the Homestead lubricated type valve.

DIRECT-INJECTION OIL ENGINES.—"Direct injection oil engines for all purposes," is the title of a new publication just issued by the Ingersoll-Rand Company, 11 Broadway, New York. The cover, which is printed in colors, illustrates the major title by portraying the Ingersoll-Rand oil engines as applied to railway, marine, powerhouse, industrial and building applications. The text matter consists of technical data and details of "PO" oil engines of 55, 110 and 150 b. hp. sizes and is profusely illustrated by illustrations of plant layouts, installation views, diagrams and engine details.

SUPERHEATERS.—A brief story of 140 years' progress in the development of the locomotive superheater is contained in a 12-page booklet issued by the Superheater Company, 17 East Forty-second street, New York. The years reviewed in this story are 1786-1926, during the former year the first superheater patent having been granted to Joseph Hateley. A few facts about Elesco superheaters, feedwater heaters, exhaust steam injectors and the superheater unit reclaiming service offered by the Superheater Company are given in a 20-page brochure entitled "Elesco and the Railroads."

THREE-CYLINDER LOCOMOTIVES.—The American Locomotive Company, 30 Church street, New York, has issued Bulletin No. 2003 illustrating and giving the principal dimensions, weights and proportions of a number of Alco three cylinder locomotives, among which are the Union Pacific and the Overland types built for the Union Pacific, the Southern Pacific type built for the Southern Pacific, the Lehigh Valley type built for the Lehigh Valley, and the Mohawk type built for the New York Central Lines. The bulletin also contains the paper on the Alco three-cylinder locomotive by J. G. Blunt before the Chicago section of the American Society of Mechanical Engineers.

PNEUMATIC TOOLS.—Under the title of "Pneumatic Tool Pocket List for Railway Shops," the Ingersoll-Rand Company, 11 Broadway, New York, has recently issued a catalogue listing various pneumatic tools which it manufactures that are applicable to railway uses. The catalogue section includes the usual specification data, covering drills of various types and sizes, grinders, hammers, sand rammers, and motor hoists, as well as sketches and dimensions of a large number of rivet sets, chisels, etc. The book is more than a catalogue, however, in that it contains 145 illustrations from photographs showing the use of the various tools in actual operation on railroad jobs and thereby giving considerable information as to the sizes and types of tools preferable for many different classes of work. The book is substantially bound in a leather substitute.

LOCOMOTIVE FEEDWATER HEATER.—Graphical charts for the computation of heat recovery and exhaust steam condensed and returned to the boiler with open-type feedwater heater operation are contained in the attractive 28-page bulletin, No. BK-1607-D, which has just been issued by the Worthington Pump & Machinery Corporation, 115 Broadway, New York. Following an outline of the advantages and economies to be gained through the use of the open-type heater, the construction, application and operation of the Type BL feedwater heater are described, the course of steam and water through the equipment being shown in a colored diagramatic view. Considerable space is devoted to locomotive photographs showing installations throughout the United States and Europe, and the technical side of feedwater heating is dealt with to some extent in the appendices in the second half of the book.

Personal Mention

General

C. M. Kirkby, special representative to the general superintendent of motive power of the Chicago, Milwaukee & St. Paul, has resigned to become mechanical engineer of the Missouri-Kansas-Texas, with headquarters at Parsons, Kans.

G. A. Miller, superintendent motive power and machinery of the Florida East Coast, with headquarters at St. Augustine, Fla., who recently made application for retirement, has been assigned to special duties relating to the completion of the Miller shops at St. Augustine, with the title of superintendent motive power and machinery, retired, pending formal retirement.

I. C. Blodgett

Irving C. Blodgett has been appointed assistant to the mechanical superintendent of the Boston & Maine, with headquarters at Boston, Mass. Mr. Blodgett was born on November 10, 1883, at Saratoga Springs, N. Y., and was educated in the Saratoga Springs High School. He entered railway service in May, 1901, as a fireman on the Boston & Maine, and in 1905 he was promoted to engineman. In 1916 Mr. Blodgett was appointed road foreman of engines, which position he was holding at the time of his recent appointment as assistant to the mechanical superintendent of the Boston & Maine.

Frank S. Robbins, whose appointment as superintendent of motive power and machinery of the Florida East Coast, with headquarters at St. Augustine, Fla., was announced in the June *Railway Mechanical Engineer,* was educated in the public schools, the Newark Technical School (at night) and at Purdue University. Mr. Robbins entered the service of the Pennsylvania in 1900, and until 1907 was consecutively machinist apprentice and special apprentice at the Altoona shops. In 1907 he became inspector in the locomotive testing plant. During 1908 he was in the service of the Berwind White Coal Mining Company as Porto Rico Fuel Demonstrator, and then he returned to the Pennsylvania as assistant general foreman. In 1910 he became assistant road foreman of engines, and in 1912, assistant master mechanic. During the war he was for a time a captain in the engineers, was then with the Railway Transportation Corps, A. E. F., France, and later became superintendent of motive power of the 16th and 20th Grand divisions respectively, and in 1918 became a major in the engineers. He returned to the Pennsylvania again in 1919 as assistant engineer of equipment in the general office. Mr. Robbins then became master mechanic at the Pittsburgh Terminal. From 1921 to 1922 he was in China as mechanical advisor to the Inter-allied Technical Board of the Chinese Eastern Railway. In 1922 he entered the service of the Pittsburgh Testing Laboratory as railway representative and district manager of the Philadelphia office, which position he was holding at the time of his recent appointment as superintendent of motive power and machinery of the Florida East Coast.

Master Mechanics and Road Foremen

D. C. Reid has been appointed master mechanic of the Indiana Harbor Belt, with headquarters at Chicago.

John T. Newkirk, assistant road foreman of engines of the Baltimore division of the Pennsylvania, has been appointed road foreman of engines of the Delaware division.

Arthur L. Fillmore has been appointed master mechanic of the Winnipeg Division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Thief River Falls, Minn.

C. H. Womack has been appointed road foreman of engines of the Ashland Division of the Chesapeake & Ohio, with headquarters at Ashland, Ky., succeeding G. H. Saunders, resigned.

J. G. Perry has been appointed road foreman of engines of the Logan Coal Sub-divisions of the Chesapeake & Ohio, with headquarters at Peach Creek, W. Va., succeeding C. H. Womack.

William F. Buscher has been appointed general master mechanic of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Shoreham, Minn., succeeding Louis Ernest, deceased.

Charles A. Bauers has been appointed master mechanic of the Gladstone Division of the Minneapolis, St. Paul & Sault Ste. Marie, with headquarters at Gladstone, Mich., succeeding A. C. Peterson.

F. W. Gratiot, road foreman of engines of the Eastern division of the Missouri Pacific, with headquarters at Jefferson City, Mo., has been transferred to the White River division, with headquarters at Aurora, Mo.

Car Department

W. J. Harris has been promoted to car foreman of the Canadian Pacific, with headquarters at Farnham, Que.

C. A. Murdock has been promoted to car foreman of the Canadian Pacific, with headquarters at Newport, Que.

William M. Nelson has been promoted to supervisor of air brakes of the Buffalo, Rochester & Pittsburgh, with headquarters at DuBois, Pa., succeeding Harry Sneck, deceased.

T. E. Forster, assistant car foreman of the Southern Pacific Lines at Yoakum, Tex., has been appointed freight car foreman of the International Great Northern, with headquarters at Palestine, Tex.

H. E. Reusch has been appointed division car foreman of the Central of New Jersey, with headquarters at Ashley, Pa. Mr. Reusch's jurisdiction extends over the L. & S. division, including Phillipsburg, N. J.

Purchases and Stores

F. V. James has been appointed storekeeper of the Chesapeake & Ohio, with headquarters at Charlottesville, Va.

T. C. Sydnor has been appointed storekeeper of the Chesapeake & Ohio, with headquarters at Ronceverte, W. Va.

R. E. Mathis has been appointed general storekeeper of the Missouri & North Arkansas to succeed L. Frost, who has resigned.

T. J. Frier has been appointed purchasing agent of the Ann Arbor and Manistique & Lake Superior, with headquarters at St. Louis, Mo.

K. P. Chinn has been appointed assistant general storekeeper of the Southern Pacific Lines in Texas and Louisiana, with headquarters at Houston, Tex.

A. C. Simmons, who has been acting purchasing agent of the Chicago Great Western, with headquarters at Chicago, has been appointed purchasing agent.

Obituary

Louis Ernest, general master mechanic of the Minneapolis, St. Paul & Sault Ste. Marie, died in Minneapolis, Minn., on May 24, after a short illness.

Harry Sneck, supervisor of air brakes of the Buffalo, Rochester & Pittsburgh, with headquarters at DuBois, Pa., died on May 16, after a brief illness.